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CONTENTS

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A. ÅNGSTRÖM ON "THE ALBEDO OF VARIOUS SURFACES OF GROUND"

By H. H. KIMBALL

[A review of *Geografiska Annaler*, 1925, H. 4]

The author introduces his paper by the statement that—

> A necessary condition that we may be able to form a clear conception of the heat economy of the earth's atmosphere and the circulation of energy within it, is that some fundamental physical properties of the atmosphere and the ground should be really given by measurements. Such properties, for instance, are the transmission of the atmosphere for sun radiation at various latitudes and at various water vapor contents, the solar constant, the convective properties and the radiation of the atmosphere and also the reflection power of the surface of the earth. The last-named property will be the object of our attention in the following paragraphs; we are going to describe a number of measurements which have been made, in the first place, in order to contribute to the fundaments for an evaluation of the average albedo of large surfaces of ground.

The measurements have been made with an Angström pyranometer,[1] first exposed so as to measure the intensity of the radiation received by a horizontal surface from above (i) and then from below (r). The instrument is provided with a glass cover that is impervious to radiation of wave-lengths greater than about 4.0μ, but transmits with small loss the direct radiation from the sun and the radiation scattered by the atmosphere that is received diffusely from the sky. The ratio r/i is therefore the albedo of the earth's surface, or the ratio of the intensity of the radiation diffusely reflected from the surface of the earth to the intensity of that received by it.

The pyranometer has been standardized by comparison with an Ångström compensation pyrheliometer, and tested for possible errors due to exposure in different positions. These latter were found to be negligible.

Since the radiation reflected from the surface of the earth, and especially from a surface covered with vegetation, may be of a different quality from that received from the sun and sky, tests were made by means of filters to ascertain if the pyranometer receiving surfaces are selectively absorptive. The tests indicate that this is not the case to a noticeable degree.

The measurements give surprisingly large values for the albedo of different ground surfaces. For example, the value for a field covered with fresh dry grass is from 0.25 to 0.33, or more than double the values heretofore derived from photometric measurements. This difference the author finds is due to the large coefficient of reflection of grass for red and infra-red radiation, which was found by measurement to be 0.45. It is pointed out that if plants have a low reflecting power for short-wave radiation and a high reflecting power for long waves the reverse must be true of their radiating or emissive powers. If this is true, plants would have "a natural safeguard against loss of heat, which under certain circumstances gives rise to killing frosts."

The reflecting power of wet ground was found to be about half that of dry ground, and the difference, while partly due to evaporation, is attributable principally to total reflection in the water films. This diminution in the reflecting power of wet surfaces, or, conversely, their increased absorbing power, compensates to a considerable extent for the loss of heat by evaporation.

It is also pointed out that the heat expended in evaporation is not a real loss of energy for the earth-air system, since it only means a transport of energy to higher altitudes. Reflection, on the other hand, means a real loss of energy income.

The vertical component of the reflection of sky radiation from a rough water surface measured by the method employed in measuring reflection from the ground was found to be about 10 per cent. The reflection of solar + sky radiation can also be measured by the same method, but the reflection of direct solar radiation alone has been obtained only through computation based upon the above measurements. These computed values agree well with those given by the formula of Fresnel except for altitudes of the sun less than 15°, where the measurements are unreliable. A curve is given showing the per cent of reflection of sunlight for different solar altitudes. The author points out the importance from a climatic standpoint of the high percentage of reflection with low sun, and especially on the sloping shores of considerable bodies of water. This fact has already received attention.

The transmission of solar radiation by green leaves was measured by coating the glass cover of the pyranometer with leaves carefully trimmed and fitted together.

The following table gives the transformation of energy by leaves under different conditions:

	Early summer (leaves with high water content)	Late summer after dry period (leaves with low water content)
	Per cent	*Per cent*
Reflection	19	29
Absorption	55.5	38
Transmission	25.5	33

Under a thick growth of trees the radiation receipt was found to be as low as 1 to 2 per cent of that received in the open. Therefore, since the reflection from the tops of such trees appears to be only 10 to 15 per cent, most of the incoming radiation must be expended in warming the upper part of the trees; but this heat may be carried away by air currents quite rapidly. On the other hand, the cooling at night would take place principally in the tree tops, and this cold air readily settles to the ground. This explains why in forests we find considerably lower maximum temperatures in summer than in the open, but only slightly higher minimum temperatures.

The coefficients of reflection for different surfaces given in this paper should undoubtedly be considered in connection with investigations in Radiation and Climate.

[1] For description see Mo. Wea. Rev. 47: 795-7, Nov., 1919, and 49: 135-8, Mar., 1921.

GRAPHICAL THERMODYNAMICS OF THE FREE AIR

By EDGAR W. WOOLARD, LEROY T. SAMUELS, and WELBY R. STEVENS

In any attempt to increase our understanding of weather phenomena, the investigation of energy relations in the earth's atmosphere is necessarily of fundamental importance; and one of the needs of modern meteorology is that of a method for the observation and representation of the physical characteristics of the free air in such a way as to make the scientific application of thermodynamics to meteorological work a practical possibility. The national meteorological institutions of the world have been established, and are maintained, at the public expense primarily for the sake of the practical services which they can render; these services must be given without fail, day after day, to the best of our ability, and take precedence over everything else, but there should also be a constant effort made to improve and extend them in order to meet still more satisfactorily the increasing demands of the public. Marked and fundamental improvements in meteorological practice, however, probably can come, if at all, only as a result of effecting and utilizing further advances in the pure science of meteorology; empirical methods, while of very great value, and in the present state of our knowledge indispensable, have serious limitations, which are soon reached, and continued investigation along empirical or semi-empirical lines, while also useful and necessary at present, can result in only limited further improvement. However inevitable empirical methods may be by reason of the difficulty of finding exact and complete solutions of the complex problems of the atmosphere, they constitute but one stage in the historical development of meteorology and its applications, and steady progress away from them is taking place. Particularly encouraging are the advances which have been made in thermodynamical meteorology.

The investigation of meteorological problems involves three steps: (1) The extension of our knowledge of the theoretical physics of the atmosphere; (2) the discovery of how to use this knowledge to attain desired accomplishments; and (3) the invention of means for making this use practicable under the conditions of daily meteorological work. All the physical processes of the atmosphere have turned out to be even more intricate than the earlier meteorologists thought them to be, and progress along each of the above three lines is necessarily slow and difficult; nevertheless every possible opportunity should be provided for further research (*1*).

The general aim of thermodynamics is the investigation of the states or conditions of material systems, as defined by the properties or qualities of the systems, and of the manner in which the variable qualities change relatively to one another as the systems undergo changes of state while receiving or giving out various forms of energy. The actually existing physical state of the atmosphere at any given time and place may be determined by aerological soundings; and the methods of thermodynamics provide means of utilizing the data so obtained in the scientific investigation of the changes of condition that constitute the sequence of weather. Great difficulties are introduced, however, by the presence in the atmosphere of highly variable quantities of water vapor; and only after many years of study has success been achieved in finding rapid and convenient, yet accurate, methods for the application of thermodynamical laws to meteorological phenomena.

FUNDAMENTAL THERMODYNAMICAL RELATIONS FOR ATMOSPHERIC AIR

The characteristic equation of state for dry air,

$$pv = MRT, \qquad p = \rho RT, \tag{1}$$

follows directly from experiment, and together with the First Law of Thermodynamics (conservation of energy) leads to the energy equation

$$dQ = c_v dT + Apdv = c_p dT - Avdp, \text{ per unit mass;} \tag{2}$$

from (1) and (2) may be obtained the isentropic equation for adiabatic processes,

$$pv^{\gamma} = const. = f(\varphi), \tag{3}$$

and Poisson's Equation

$$\frac{T}{T_0} = \left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}}, \text{ or } \frac{p}{p_0} = \left(\frac{T}{T_0}\right)^{\frac{\gamma}{\gamma-1}} \equiv \left(\frac{T}{T_0}\right)^m, \tag{4}$$

which gives the relation between temperature changes and pressure changes in adiabatic processes. In the above equations, p denotes gas pressure; M, mass; ρ, density; R, the gas constant (2.870×10^6 c. g. s. for dry air, referred to 1000 mb. and 273° Abs.); T, absolute temperature; Q, energy in thermal units; c_v, specific heat of dry air at constant volume (0.1715); A, the reciprocal of the mechanical equivalent of heat [$1/(4.18 \times 10^7)$]; v, volume; c_p, specific heat of dry air at constant pressure (0.2417); φ, entropy; γ, ratio of the specific heats of dry air (1.40); $m = 1/0.286$; and the zero subscripts refer to (arbitrary) initial conditions.

If the air contains water vapor, the preceding equations still hold very closely as long as saturation is not attained, only the third decimal place in the value of $(\gamma-1)/\gamma$ being changed (0.288 is a fair average value); if great accuracy is desired, however, we must replace (1) by

$$p = R\left(\rho + \frac{\rho''}{\epsilon}\right)T, \tag{5}$$

where p is the pressure of the mixture of dry air and water vapor, ρ the density of the air in the mixture, ρ'' the density of the water vapor constituent; $\rho' = \rho + \rho''$, ρ' being the density of the mixture; and ϵ is the specific gravity of aqueous vapor (0.622). If the specific humidity, or weight of water vapor per unit weight of the mixture, be denoted by $q = \rho''/\rho'$, then

$$p = \rho' R(1 + 0.605q)\, T \equiv \rho' R'' T \equiv \rho' R T'', \tag{6}$$

where T'' is the virtual temperature; or, again, if the "mixing ratio," or weight of water vapor per unit weight of dry air present in the mixture, be $x = \rho''/\rho$, we have

$$p = \rho R\left(1 + \frac{x}{\epsilon}\right)T \equiv \rho R' T; \qquad (7$$

x is the weight of aqueous vapor in a weight $(1+x)$ of the mixture, and $q = x/(1+x)$, while $x = q/(1-q)$.

For moist air, the energy equation (2) becomes, for weight $(1+x)$ of mixture,

$$dQ = (c_p + x c''_p)dT - A\left(1 + \frac{x}{\epsilon}\right)RT\frac{dp}{p}, \tag{8}$$

whence m in (4) has the value

$$m=\frac{c_p}{AR}\left[\frac{1+\frac{c''_p}{c_p}x}{1+\frac{x}{\epsilon}}\right]=3.441\left(\frac{1+2.023x}{1+1.608x}\right), \qquad (9)$$

in which c''_p is the specific heat of unsaturated water vapor at constant pressure.

In meteorology we are usually interested in processes involving continuously decreasing pressure (as in upward convection). The preceding equations supply a sufficient description of such processes as long as saturation is not attained, i. e., throughout the "dry stage"; when condensation begins, these equations cease to apply, and the "rain," "hail," and "snow" stages are characterized by more complicated equations, such as

$$\log\frac{p'}{p'_0}=\frac{c_p+\xi c}{AR}\log\frac{T}{T_0}+\frac{M}{AR}\left(\frac{xr}{T}-\frac{x_0r_0}{T_0}\right), \qquad (10)$$

which describes the rain stage; in this equation ξ is the total weight of water present (liquid and vapor) per unit weight of dry air present, c the specific heat of water, r the latent heat of evaporation, p' the partial pressure of the dry air, M the logarithmic modulus, and the subscripts refer to initial conditions.

In the applications of thermodynamics to practical meteorological work, the hail and snow stages may be ignored, as Shaw has pointed out.

When rain begins to fall, there is a decrease in the total energy of the air; the condition in which there is no addition or subtraction of heat, but in which all condensed water falls out, is called "pseudo-adiabatic," or irreversible adiabatic, in contradistinction to the true adiabatic or "reversible adiabatic" condition; the above adiabatic equations can be reduced to the pseudo-adiabatic by dropping the water terms.

Of fundamental importance in thermodynamical meteorology is the quantity known as potential temperature: The potential temperature of a mass of air is the absolute temperature that would result if the air were brought adiabatically to some arbitrary standard pressure which Shaw selects to be 1,000 mb. (Shaw names the potential temperature referred to this standard the "megatemperature.") The potential temperature derives its importance from its close connection with the basic (but abstract and elusive) thermodynamical concept, *entropy;* from the characteristic equation and the equation of energy we have

$$\phi=c_p\log\frac{T}{T_0}-AR\log\frac{p}{p_0}\text{ per unit mass,} \qquad (11)$$

in which the zero subscripts refer to the (arbitrary) zero point from which the entropy, ϕ, of the *dry air* is reckoned, and which Shaw takes to be 200° Abs. and 1,000 mb. In terms of potential temperature, θ, we have by (11) and (4),

$$\phi=\log_e\left(\frac{\theta}{200}\right)^{c_p}=c_p\log\theta+const.\ \frac{\text{joules}}{\text{degree}}. \qquad (12)$$

The total entropy of *moist air* includes the entropy, ϕ, of the dry air, and also that of the water vapor; the potential temperature is merely another form of expression for the entropy of the dry air, no allowance being made for the latent heat of the water vapor mixed with this air; the quantity ϕ above may be referred to as "realized entropy," having been realized in the form of temperature. The meteorologist may merely look upon ϕ as a numerical magnitude, *defined* by (12), proportional to the potential temperature. The vertical distribution of potential temperature determines the stability of the atmosphere, and the possibility and extent of convectional processes. Potential temperature may be increased by heat of condensation, but the total entropy of the mixture remains unchanged.

Numerous tables have been prepared and published to facilitate computations with the above equations; and from these tables, graphs may be prepared if desired.

GRAPHICAL REPRESENTATION OF THE THERMODYNAMICAL STATE OF THE FREE ATMOSPHERE

The common method of portraying the physical state of the atmosphere by plotting pressure, temperature, etc., against height is entirely unsuited to the use of the data for the scientific investigation of the thermodynamical mechanism of meteorological phenomena; it is necessary to plot the data in some one of the forms employed in thermodynamics. The method first introduced into meteorology is that embodied in the well-known Neuhoff diagram (*2*).

The Neuhoff diagram shows what will happen during the ascent of air which contains a given amount of water vapor. This diagram consists of a groundwork of adiabatic lines for dry air and reversible adiabatics for saturated air, computed from equations such as (4) and (11), referred to temperature and logarithm of pressure as coordinates. It is also possible to graph the irreversible adiabatics. In reality, during ascent (due, e. g., to local heating above the temperature of the environment) the irreversible adiabatics are the ones approximately followed, while on descent the lines followed will be practically indistinguishable from those for dry air. On the groundwork may be superposed the graph of the data obtained from an aerological sounding; the resulting diagram is highly useful in the study of thermodynamical processes in the atmosphere, e. g., thermal convection (which has been found to present some of the most difficult problems of meteorology and to be not at all the simple and well understood phenomenon it formerly was thought to be), as well as in the graphical reduction and representation of daily upper air observations, and their application to the determination of the structure of the atmosphere.

The Neuhoff diagram has been adapted to practical use in daily meteorological work at the Lindenberg Observatory (*3*). The conception of great masses of moving air, differing to a greater or less extent from one another in respect to temperature, humidity, velocity, etc., and separated by more or less well-marked "surfaces," plays an important rôle in modern meteorological ideas of the dynamic mechanism of atmospheric phenomena; it is, e. g., a leading element among the ideas of the Bjerknes school, now being successfully applied to forecasting in several European countries. The location of the air streams and boundary surfaces is much facilitated by aerological observations, frequently being difficult or impossible from surface observations alone; but for this purpose the data must be put in proper form, and, for practical use such as in forecasting, methods must be available for doing this very quickly.

The Lindenberg Observatory employs what is called *adiabatic paper*, upon which are printed the dry air adiabatics (computed from equation (4), with $1/m=0.288$ and $p_0=750$ mm. or 1,000 mb.) referred to temperature and logarithm of pressure as rectangular coordinates, and curves of specific humidity computed from

$$q=\epsilon\frac{e}{b-e\,(1-\epsilon)}, \qquad (13)$$

in which e is the vapor pressure and b the barometric pressure. Temperature, vapor pressure, relative humidity, and wind are each plotted against pressure, the fundamental meteorological variable; printed scales are

provided for the first two, while the other two are entered at any convenient place and the scales written in (using, e. g., 10° of the temperature scale for the range 0% to 100% of humidity). Provision is made for obtaining virtual temperatures graphically by Bjerknes' method. *See Fig. 1*, which is fully explained in the legend.

A pressure-height curve, with heights as abscissae, may be drawn at any convenient place on the diagram; and may be constructed either from heights computed in the ordinary way, or graphically; for convenience, an altitude scale may then be written alongside the pressure scale of ordinates also.

The pressure-height curve is constructed graphically out of a number of parts or sections, each of which is drawn parallel to the adiabatic which falls nearest the mean temperature of a stratum that has a uniform lapse rate; such strata are indicated in Figure 1 by the portions of the temperature curve between the heavy horizontal lines. It is obvious that where no marked change in the lapse rate occurs, the mean temperature of the stratum will be the same no matter what the lapse rate may be, provided the lapse rate curve be drawn through the midpoint of the stratum, i. e., the point whose actual temperature is equal to the mean temperature of the stratum. The nearer the actual lapse is to the adiabatic lapse rate, the greater the pressure interval may be taken to be, i. e., the fewer the sections making up the complete pressure-height curve. In the case of pronounced temperature inversions, therefore, care must be taken to use sufficiently small pressure intervals. In the construction of the curve by the above method, it is assumed that the adiabatic lapse rate is 1°/100 m., hence the resulting indicated heights must be increased by 1.6 per cent if accuracy is desired.

Potential temperatures and specific humidities may be read off immediately from the diagram; the former are obtained from the intersections of the pressure-temperature curve with the adiabatics, the latter from the intersections of the pressure-vapor pressure curve with the specific humidity curves. Potential temperatures have been very little used in practical meteorology, probably because of the time required for their calculation; however, under many circumstances, e. g., when large pressure differences exist in time or space, comparisons based on actual temperatures may be quite misleading, potential temperatures being preferable.

In Figure 1 and Table I are shown the results, obtained graphically, of a kite flight made at Ellendale, N. Dak., on February 2, 1925, chosen because of the extreme deviation of the lapse rate from the dry air adiabatic. It will be seen that the differences between the altitudes determined graphically and those found by computation are all small, the former in practically every case being less than 1 per cent in error as compared to the latter. Such a graph gives the complete data of the flight in very compact and readily comprehensible form; values of the meteorological elements may be read off for any desired level as well as for any given pressure, and the corresponding altitude for any pressure is directly obtained; pronounced temperature inversions, and all other interesting features present are evident at a glance; and the accuracy is nearly as great as that of the customary tedious computation, with its resulting tabulation that fails to exhibit the conditions in any conspicuous manner or to furnish potential temperatures, etc.

When great accuracy is desired, the use of the graphical method affords but little gain in time; but for immediate practical use in forecasting, a sufficiently accurate graph can be constructed within a few minutes, directly from the data as recorded on the meteorogram. In Figure 1, the temperature curve is divided up into a relatively large number of subdivisions, each having a different lapse rate; it should be clearly understood that for use in forecasting it would be sufficiently accurate to divide this curve into only two divisions, and thus to construct the pressure-height curve in a negligible amount of time.

TABLE I

[Ellendale, N. Dak., Feb. 2, 1925]

Altitude by computation	Altitude by graph	Difference
(m.) m. s. l.	(m.) m. s. l.	(m.) m. s. l.
533	549	+16
1362	1361	−1
1497	1494	−3
1917	1900	−17
2783	2763	−20
2930	2926	−4
3286	3292	+6
3669	3658	−11
3800	3780	−20
4240	4211	−29
4316	4308	−8
4358	4328	−30

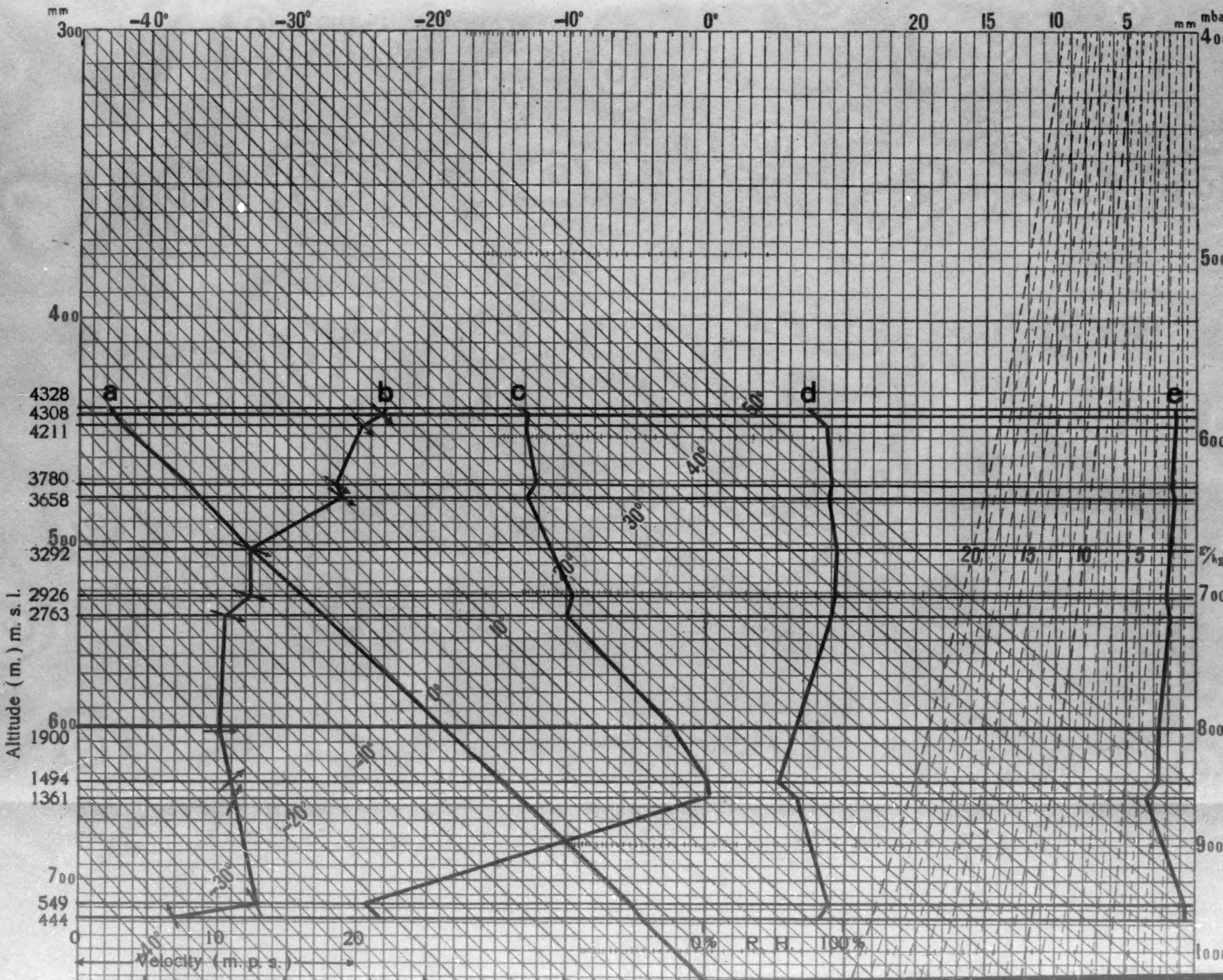
However, the use of temperature and pressure (or logarithm of pressure) as coordinates has the distinct disadvantage that energy can not be represented graphically; and energy relations are what we are ultimately interested in when investigating the physical phenomena of the atmosphere. On the common pressure-specific volume "indicator diagram," energy in dynamical units is represented by areas, but the areas enclosed between adiabatics and isothermals are greatly elongated parallelograms, so that interpretation and application are difficult. After a prolonged investigation of various forms of thermodynamical diagrams, Sir Napier Shaw and his colleagues have finally selected temperature and entropy as the most suitable coordinates, and have set out the results of aerological soundings by means of what they call the *tephigram* (tē-phĭ-gram) (*4*).

THE TEPHIGRAM

The groundwork of the tephigram is essentially the Neuhoff diagram transformed to temperature-entropy coordinates, and extended to lower pressures and temperatures; for the convenience of the meteorologist, however, the coordinates are represented as temperature and logarithm of potential temperature. This groundwork enables one to follow the changes which will take place in the condition of dry air, or in the condition of air originally saturated, as the pressure is reduced in any adiabatic process; dry air alone is regarded as the "working substance," or substance that goes through the thermodynamic changes, and any moisture carried along is regarded as a reservoir of latent energy—a possible supply of heat—that becomes realized when condensation takes place, all other effects of water vapor being neglected. Only the realized entropy is shown; loss of water, and latent heat of condensation, are allowed for by increasing the realized entropy of the dry air accordingly. The dry and the irreversible saturation adiabatics, isobaric lines, and lines showing the number of grams of water vapor necessary to saturate one kilogram of dry air are shown. Areas represent energy.

The groundwork shows the environment of pressure through which dry or saturated air would have to pass if it ascended either spontaneously or through being forced up; and to bring the condition of the air in a

ADIABATIC CHART




a
b
c
d
e
Altitude (m.) m. s. l.
4328
4308
4211
3780
3658
500
3292
2926
2763
600
1900
1494
1361
700
600
700
800
900
g/kg
20
15
10
5
50°
40°
30°
20°
10°
0°
-10°
-20°
-30°

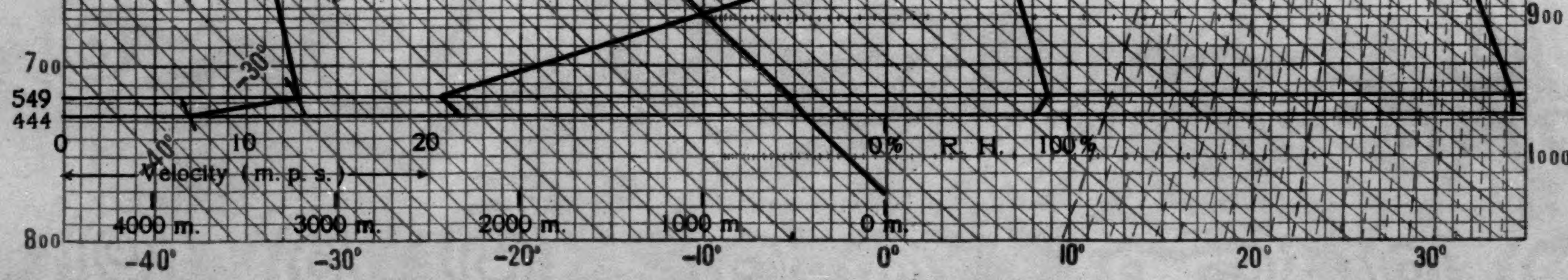


FIG. 1.—Graphical representation of kite record from Ellendale, N. Dak., February 2, 1925. (*a*) Pressure-height curve referred to height scale along abscissae axis; (*b*) pressure-wind curve, showing velocity and direction; (*c*) pressure-temperature curve; (*d*) pressure-relative humidity curve; (*e*) pressure-vapor pressure curve. Figures along ordinate scale on left side are obtained from pressure-height curve, and indicate the altitudes of the points at which the lapse rate changes. Small vertical lines on the even pressure lines indicate amount of correction to be applied to actual temperature to obtain virtual temperature. Broken lines running upward along right side of graph are specific humidity curves. Upper right abscissae are vapor pressures. Diagonal full lines from lower right to upper left are dry adiabatics, and give the potential temperature (°C.) referred to standard pressure of 1,000 mb. Ordinates are logarithms of pressure (mm. on left, mb. on right). Upper and lower abscissae are Centigrade temperatures. Form No. 1126-Aer. is a reproduction of the form used by the Lindenberg Observatory.

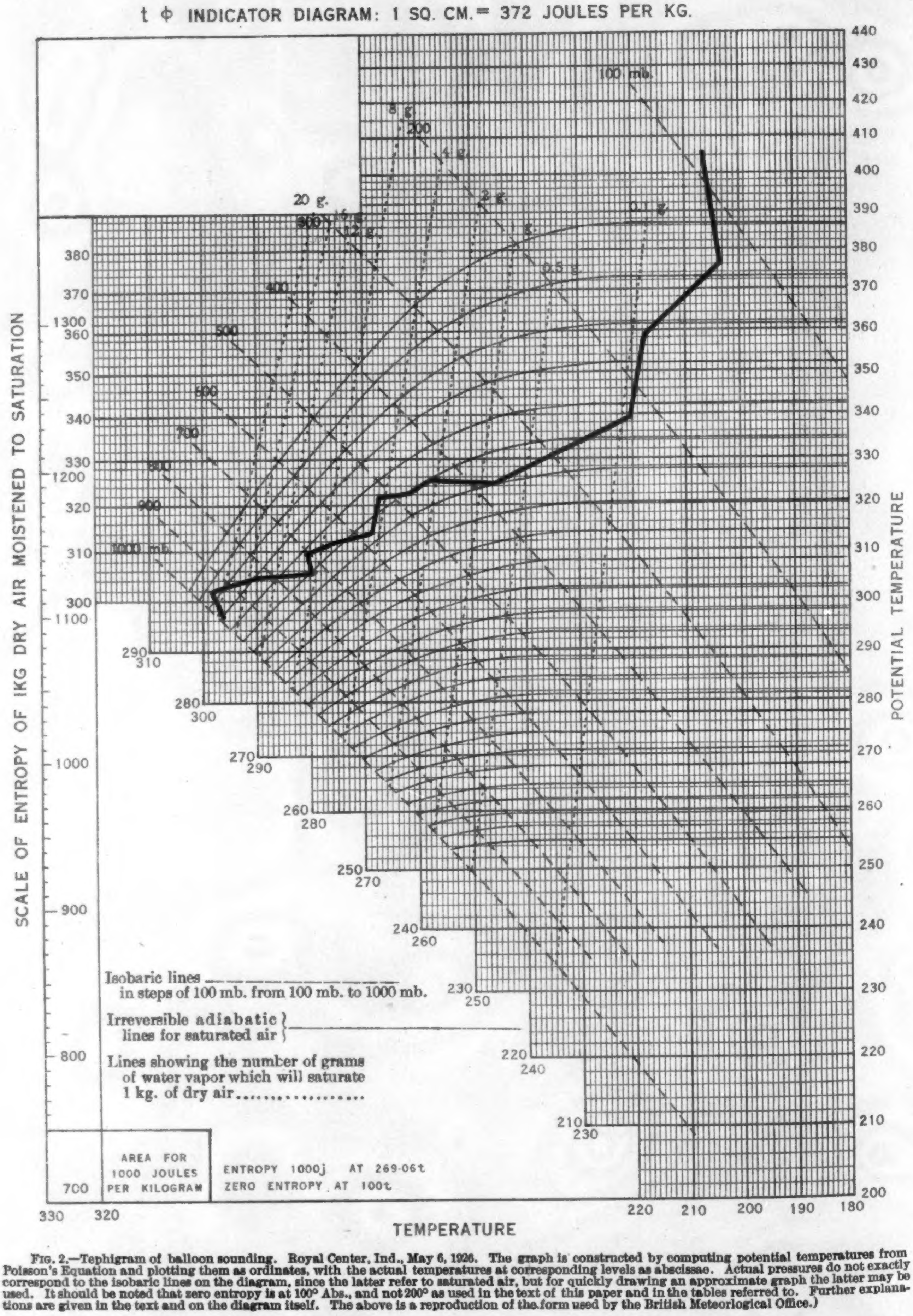


FIG. 2.—Tephigram of balloon sounding. Royal Center, Ind., May 6, 1926. The graph is constructed by computing potential temperatures from Poisson's Equation and plotting them as ordinates, with the actual temperatures at corresponding levels as abscissae. Actual pressures do not exactly correspond to the isobaric lines on the diagram, since the latter refer to saturated air, but for quickly drawing an approximate graph the latter may be used. It should be noted that zero entropy is at 100° Abs., and not 200° as used in the text of this paper and in the tables referred to. Further explanations are given in the text and on the diagram itself. The above is a reproduction of the form used by the British Meteorlogical Office.)

vertical section of the atmosphere at any time, as revealed by an aerological sounding, into relation with the thermodynamical properties of dry and saturated air as shown by the temperature-entropy diagram, the sounding is plotted on the groundwork; the resulting representation is called a tephigram. The tephigram affords facilities not hitherto available for studying the physical processes in the atmosphere; and many practical applications are possible. See Figure 2, fully explained in the legend.

Spontaneous adiabatic ascent of unsaturated air, in which no kinetic energy or momentum is shared with the environment, will be along a horizontal isentropic line on the diagram (since the potential temperature remains constant); spontaneous ascent of saturated air will be along the saturation adiabatic through the starting point; in any case, a return journey will be along a horizontal line. The amount of water condensed out can be determined from the diagram. Spontaneous ascent of dry air can therefore occur only in regions where the graph of the sounding slopes downward from a horizontal line, implying instability for dry air, i. e., a superadiabatic lapse rate; stability is indicated by a deviation of the graph upward from the horizontal, regions of convective equilibrium by no deviation from a horizontal (constant potential temperature), inversions by a deviation to the left of the vertical, isothermal regions by no deviation from a vertical. Spontaneous ascent of saturated air can occur only in regions where the saturation adiabatic through the starting point keeps on the warm side of, i. e., above, the tephigram, implying instability for saturated air; a deviation of the graph of the sounding upward from the saturation adiabatic indicates stability for saturated air. Spontaneous ascent of dry air will continue until the tephigram again intersects the horizontal isentropic through the starting point, when the rising air will come to equilibrium, possibly after some oscillations (unless in the course of its ascent it has become saturated, in which case a new set of conditions will supervene); spontaneous ascent of saturated air will continue, perhaps with increased acceleration (condensed water being lost on the way), until the tephigram again intersects the saturation adiabatic through the starting point, when the ascending air will come to rest after oscillations of more or less violence or the transformation of its potential energy into some stable kinetic form, the final potential temperature being marked by the ordinate of the extreme point reached.

The energy consumed or given out per kilogram of (dry or saturated) air in any convectional process is represented by the area inclosed by the tephigram and the adiabatic followed during the process between the two points of intersection (starting point and point of equilibrium); in the case of spontaneous ascent the area is positive, the tephigram lying below the adiabatic, and when spontaneous ascent is not possible the area is negative, lying below the tephigram; a positive area is to be described by going around it in a clockwise direction.

Similarly, a complete thermodynamic cycle can easily be followed out on the tephigram groundwork, and the efficiency determined.

The groundwork of the tephigram refers only to saturated air, but the air represented by any point on the graph of the sounding may be in any state of humidity. A dew-point curve, or *depegram* (dē-pē-gram), may also be plotted, however; the isobaric curve through a point of the tephigram is followed until it intersects the temperature line corresponding to the dew point, and the intersection determines a point of the depegram. The intersection of the adiabatic through the starting point of the ascending air with the vapor-content line through the corresponding point of the depegram gives the point at which direct adiabatic ascent would bring the air to saturation.

The degree of instability, and the amount of energy available, at any level, for the production of showers, thunderstorms, and other weather disturbances, may be determined as follows: Calculate the weight of water vapor per kilogram of dry air actually present in the air at the level, draw a horizontal line through the corresponding point on the tephigram to the temperature line at which the above weight of water vapor would be the saturation amount; then the available energy of the actual nonsaturated air is represented by the area, if any, inclosed by the saturation adiabatic through the latter point and the tephigram. An investigation by Dines has shown, e. g., that the amount of available energy and the level at which it occurs are intimately connected with the subsequent occurrence of thunderstorms (*5*).

APPENDIX

General considerations concerning the energy in the earths' atmosphere, with references to the literature, are given by Woolard, *Mon. Weath. Rev.*, 54, 254–255, 1926. A lucid exposition of fundamental thermodynamical theory will be found in Birtwistle, *Principles of Thermodynamics* (Cambridge Press, 1925). The thermodynamical equations for the atmosphere are developed by Humphreys, *Physics of the Air* (Philadelphia, 1920); Exner, *Dynamische Meteorologie* (2te aufl., Wien, 1925); Shaw, in *Dict. Appl. Phys.* (Glazebrook, ed., vol. III, London, 1923); and others.

A table of the 0.288th powers of numbers, useful in computing potential temperatures, will be found in the *Quar. Jour. Roy. Met Soc.*, 47, 196–202, 1921. Virtual temperatures are tabulated. and also determined graphically, in Bjerknes, *Dynamic Meteorology and Hydrography*, Pt. I, Washington, 1910. Tables of the saturation pressure and density of water vapor will be found in many places. The weight of water vapor required to saturate a kilogram of dry air is tabulated by Shaw in Table IV of his article in *Dict. Appl. Phys.*, vol. III, and the values of R′ in eq. (7) are given in Table V; total and realized entropy at various pressures and temperatures are set out in Table VI.

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WAVES AND VORTICES ON A QUASI-STATIONARY BOUNDARY SURFACE OVER EUROPE

A review [1] by H. WILLETT

This paper contains a thorough analysis of the weather situation over central Europe from October 8 to 13, 1923, and a rather brief study of the distribution of the meteorological elements in the air masses throughout the region under consideration. The authors do not go into the elementary details of the problem of establishing the position of the boundary surface between the air masses of polar origin and those of tropical origin in the present situation. They are concerned rather with the phenomena which develop and travel along this front. Furthermore, on their charts they include no data that seem to be subject to local disturbing influences which render the observed values of the meteorological elements non-representative. Hence on these charts the situation appears more clear-cut and simple than it really is.

The developments which lead to the establishment of the quasi-stationary front may be briefly traced as follows. An area of low pressure has moved slowly across the north Atlantic Ocean towards the coast of Norway, where, as it began to fill up, a secondary formed to the south. This caused a pronounced trough, the mother depression of the series of cyclonic phenomena under discussion. Behind this depression the polar air spread out in several waves in an east-southeast direction. But those waves did not work further south than about latitude 49°, along which they moved. To the south, extending from the Azores eastward over southern France, was a marked Azores HIGH, almost stationary, which gave rise to a vigorous west-southwest air current of tropical origin extending up to the forty-ninth parallel. Hence, by the morning of October 10, along approximately this parallel, we have a marked discontinuity between two air currents of polar and tropical origin. Equilibrium conditions along this front are satisfied, for it remains practically stationary for 48 hours, extending throughout the field of observation from about longitude 15° west to 30° east, or more. Along much of this front we have ascending air motion and warm front rain, with the typical warm front cloud formations.

The first disturbance on this front to be studied is a so-called wave disturbance (Wellenstörung). A degenerate cyclone moves, during the 10th and 11th, across the North Atlantic within the polar air. The longitudinal component of the circulation around this weak center results in the development, on the front, of a distinct warm sector (or protrusion northward of warm air), followed by a cold sector in the rear. The disturbance moves rapidly from west to east along the front, but due to the lack of any vigorously southward moving cold air masses behind the warm sector to effect occlusion, it remains flat and open. The transition from tropical air (warm west-southwest wind) to polar air (cold west-northwest wind), is everywhere very abrupt and marked—a true discontinuity. The wind velocities are everywhere high, but highest in the warm sector. The disturbance as a whole moves eastward along the front much faster than the air itself is moving, or than the disturbance which caused it. Hence it appears to move as a true wave along the boundary of air masses of different density, and, once having been generated, it seems to be independent of the parent cyclone. Behind the disturbance the front is completely restored to its original condition. Several other smaller disturbances move along the front as waves, having true (though very small) warm and cold sectors, with abrupt transitions and wind shifts.

By the morning of the 11th the second principal disturbance makes its appearance over the western portion of the front. It originates, like the wave disturbance, under the influence of a cyclone in the polar air far to the north, which gives rise to a warm sector in the front. But the further development is very different. In this case the disturbing cyclone is much more vigorous, with an extensive mass of southward moving polar air behind it. This cold air, pushing into the circulation of the front, thus increases the circulation around it, and effectively occludes the warm sector. Hence this disturbance develops into one of the vortex type, not remaining merely a wave on the front. It becomes eventually independent of the front on which it was generated. As a result of the increased vortical circulation, the front between the polar and tropical air masses loses its very sharp outline. In this disturbance the transition from warm air to cold air, from west-southwest to west-northwest winds, is much less abrupt than in the case of the wave disturbance, as shown by thermographs and wind direction traces. There is a wavelike irregularity in the traces which indicates that the cold air arrives in successive small waves, or that the front, is now made up of a succession of small fronts or layers. This disturbance eventually moves away from the front far into the polar air mass to the northeast, becomes occluded, and joins the mother depression over northern Norway. Its passage destroys the equilibrium on which the maintenance of the front depended. Hence the cold air masses behind the disturbance, spreading southward and eastward, eventually reach the general trade wind circulation, displacing the monsoon LOW over the Egyptian Sudan 5° to the south, and finally ending that particular family of cyclones. The next family, according to the Bergen School, must start with a new and distinct front far to the north.

In their introductory remarks the authors compare briefly the Bergen theory of the origin and maintenance of cyclones (that each cyclonic family is a series of waves in various stages of development on a separate front), with the so-called Barrier theory of Exner (Riegel theorie der Zyklogenese). According to this theory LOWS are formed in the lee of masses of heavy polar air spreading southward into swiftly moving westerly winds of tropical origin. Although Bergeron and Swoboda do not definitely deny the possibility of explaining some cyclones on that theory, they suggest a number of difficulties in it. The chief objection to the Bjerknes wave theory, namely, that no one has ever shown a cyclone to be truly a wave on a front between air masses of different density, or that waves of such an amplitude are possible, they regard as answered by their analysis. This, they believe, proves almost conclusively that disturbances of a truly wavelike nature arise in the case under discussion. Even the disturbance that destroyed the front had that origin. But the authors make no statement as to whether all cyclones can be so explained, although that is the theory they seem to wish to establish. This theory as a universal explanation of cyclonic development seems inadequate, but it does appear to fit the phenomenon of cyclone families better than Exner's barrier theory.

[1] "Wellen and Wirbel an einer Quasistationären Grenzflache über Europa," Veröffentlichen des Geophysikalischen Instituts der Universität, Leipzig, Bd. III, Heft 2, by Bergeron and Swoboda.

In the second part of their paper the authors undertake a brief but comprehensive study of the distribution of the meteorological elements in the air masses throughout the regions they have been observing. They attempt also a comparison of the observed facts with the conditions to be anticipated from the Bergen theories. This is too detailed a matter to go into here, but their complete success in explaining all the outstanding phenomena in terms either of the front theory or most plausible local disturbing influences, is worthy of note. The types of weather involved, in general, may be classified in six groups, which, roughly speaking, occur in six latitudinal zones parallel to the front, and are completely explained by the kinds of meteorological activity to be expected at corresponding distances on either side of the front.

One of the most interesting facts brought out in this study of the characteristics of air masses of polar and tropical origin has to do with the distribution of the temperature, or potential energy. Although the author's data from the upper air levels are rather scanty, and local disturbing influences, especially at the mountain stations, are hard to eliminate, they find that up to at least four kilometers in the tropical air masses the isentropic surfaces (surfaces of constant potential temperature) are horizontal, while in the polar air they slope increasingly toward the ground as they approach the front. In the front itself, where the transformation from potential energy to kinetic energy largely takes place, and where, consequently, the center of gravity of the system is sinking, this slope of the isentropic surfaces is, of course, very steep. But the fact that these surfaces are sloping in the polar air and horizontal in the tropical air is in accord with two observed facts in this quite typical case; first, that there are secondary cold fronts or surfaces of discontinuity in the polar air, and second, that the tropical air appears to be continuous and homogeneous. Whether these are characteristic of all air masses of polar and tropical origin, respectively, can not be said without more study.

RESULTS OF AEROLOGICAL OBSERVATIONS MADE AT VARIOUS STATIONS IN THE NETHERLANDS DURING 1924

[Review by L. T. Samuels based on translation by W. W. Reed of the Results of Aerological Observations in 1924. Koninklijk Nederlandsch Meteorologisch Instituut]

Aerological observations by means of aircraft appear to be practicable on 86 per cent to 90 per cent of the days throughout the year. During the summer this percentage rises to 100 while in the winter months it decreases considerably especially during the period from November to February when fog often makes observations impossible for a week at a time. Experience shows that fog is the only condition which entirely prevents such observations. At the De Kooij flying field an unbroken layer of low clouds frequently presents a serious obstacle in the attainment of satisfactory flights on account of the danger in coming down over the sea.

The accompanying table gives the number of airplane observations made at Soesterberg and De Kooij together with the mean and maximum altitudes attained for each month and the year:

		January	February	March	April	May	June	July	August	September	October	November	December	Year
Number observations	Soesterberg	19	22	30	25	31	26	32	27	27	24	27	18	308
	De Kooij	10	15	26	17	19	15	15	13	18	21	10	5	184
Mean altitude (m.) M. S. L.	Soesterberg	4,821	4,588	4,598	4,999	5,345	5,434	5,638	5,514	5,478	5,295	5,276	5,172	5,180
	De Kooij	4,308	4,760	4,976	4,975	4,649	4,722	4,684	4,369	4,269	4,085	4,204	3,433	4,453
Max. altitude (m.) M. S. L.	Soesterberg	5,500	5,063	5,723	5,738	6,108	6,079	5,902	6,088	6,381	5,943	5,837	5,769	6,381
	De Kooij	5,092	5,036	5,204	5,263	5,431	5,384	5,671	6,279	6,525	6,012	5,291	4,987	6,525

This is most certainly a remarkable record of achievement and striking testimony to the practicability of this comparatively new method of observation. At Soesterberg, where the largest number of observations was made, it will be seen that, beginning with May, all of the monthly means were over 5,000 meters, while for July and August they were 5,638 meters and 5,514 meters, respectively. Ascents to over 6,000 meters were made at this station eight times, while 72 per cent of the flights went above 5,000 meters elevation.

Not a single accident occurred at either station in connection with these flights throughout the year. One forced landing owing to the sudden appearance of fog was made safely. A night airplane observation, made at De Kooij at 10 p. m. on March 10th and reaching an altitude of 4,526 meters, is deserving of special notice.

Seven sounding balloons were released during the year. Five of the instruments were recovered, all of which reached the stratosphere. In one of these cases, however, the clock stopped before the stratosphere was reached. The remaining four indicated the altitude and temperature of the base of the stratosphere to be as follows: March 19, 8,801 meters, −58.5° C.; May 23, 10,063 meters, −48.6°; May 25, 8,629 meters, −50.2°; July 19, 9,220 meters, −50.2°. The maximum altitude reached in this series of sounding balloon observations was 18,605 meters at which elevation the temperature was −48.7° C., on May 25.

Owing to the illness of the personnel only 13 kite flights were made during the year at Duin-dal. These reached an average altitude of 1,281 meters, the maximum being 1,564 meters.

Pilot balloon observations were made in general twice daily with occasionally three observations daily in summer. At De Bilt 436 observations were made of which 290 were followed up to over 1,500 meters, 110 to 4 kilometers, 56 to 6 kilometers, 33 to 8 kilometers, and 14 to 10 kilometers. The maximum altitude was 13.7 kilometers reached on May 27. At De Kooij the number of pilot balloon observations was 279, of which 157 reached an elevation of over 1,500 meters.

The above data are given in very complete and excellently arranged tables for convenient use of the investigator. No discussion is made, however, of the observational data appearing in the tables.

THE DIRECTION OF WIND AND CLOUD OVER TENERIFFE

[Translation by B. M. Varney of the summary of a paper under the above title by H. von Ficker in *Festschrift der Zentralanstalt für Meteorologie und Geodynamik, zur Feier Ihres 75-Jährigen Bestandes im Jahre 1926.* Issued 1926 by the Akademie der Wissenschaften, Wien.]

[NOTE.—Von Ficker's discussion is based on data from the following stations in the Canary Islands:
Puerto de Orotava, altitude 100 meters, on the north coast of Teneriffe; observations for 1905–1913.
El Guimar, 370 meters, above the southeast coast of Teneriffe; 1912–1916.
Laguna, 547 meters, in eastern Teneriffe; 1911–1923.
Las Palmas, 12 meters, on Gran Canaria; 1911–1920.
Cañadas, 2,100 meters, in the crater of the Peak of Teneriffe; 1910–1915.
Izaña 2,367 meters, in an open exposure on the crater's edge, Peak of Teneriffe; 1916–1923.]

In the lower situations on Teneriffe (Orotava and Guimar) wind direction is very markedly affected by local influences (land and sea breezes). From this fact results, for instance, on the north coast, an extraordinary great frequency of northeast winds, even outside of the true trade wind period. The trade wind period is here marked by the fact that the northeaster is the dominating wind of both morning and evening, and suppresses the land wind. On the southeast coast, one finds in the wind shadow of the high mountains of the island an easterly to southeasterly wind, counterpart of the trade wind flow. Its frequency outside of the true trade wind period is due to the sea breeze, and at that period [during the absence of the trade]—in contrast to the summer—it is confined to the warmest days only.

The northeast direction of the trade wind is not found at Las Palmas and Laguna. There the trade blows as a northwest or north wind, while at Mogador on the adjacent African coast the northeast wind dominates entirely. Whether in the region of the Canaries on the open sea the trade wind flows more from north and northwest than from northeast can not be told from the material dealt with.

While Orotava, Guimar, Las Palmas and even Laguna lie in the region of the lower, true trade wind stream, the antitrade (southwest) blows throughout the year at those heights in which the formation of alto-cumulus is most frequent. In the antitrades are to be included the south and southeast winds, which are considerably more frequent in summer. Winds which carry air to lower latitudes are, in the region of the A-Cu, much more rare than in the Ci level, where, besides the almost completely dominant antitrade, west and especially northwest winds are much more frequent than at the A-Cu level.

Between the lower trade wind stream and the antitrade lies the "mixture layer" or "transition zone," discovered and given this name by Hergesell. In this zone lie the stations of Izaña and Cañadas. The view that the winds in this zone are among the most changeable in the atmosphere is amply confirmed by the distribution of wind directions at Cañadas and by the trajectories of Cu and N, since the southwest wind is nearly as frequent as the southeast. That is to say, we must conclude that these altitudes lie alternately in the realms of trade and antitrade. But, at Izaña, heavy northwest winds predominate the whole year through, to such an extent that they represent the most stable flow of all the layers up to the cirrus. In the region of the Canaries, at no height is there a flow which better deserves the name of trade wind than this northwest stream at Izaña, than which only the southeast wind of winter is more frequent.

[1] Sverdrup, H. U., Der Nordatlantische Passat. Veröffentl. des Geophysikal. Inst. der Universität Leipzig, Band II, Heft 1, Leipzig, 1917.

Since we can not well doubt the existence of this flow from the northwest, it must be regarded as an important member of the trade-wind system. According to the masterly presentation by Sverdrup [1] the transition from trade to antitrade is completed by means of a left-hand turning of the wind, so that in the boundary layer between the two streams the northwest winds blow. If, following this interpretation, we regard the northwest wind at Izaña as the transition member between trade and antitrade, we must simply renounce the view that the transition layer is a region of very changeable winds. With respect to the origin of this northwest wind, Sverdrup adheres to the view of Wenger, who ascribes the transition to the interchange of mass between trade and antitrade. Plausible as this conception becomes as a result of Sverdrup's calculations, three difficulties arise, nevertheless, in connection with the view that Izaña's wind conditions may be taken as representative of this boundary region.

First, the northwesterly movement in the so-called transition layer occurs much more frequently than the movements above or below; that is, the flow from the northwest in the transition layer predominates much more strongly than does the trade below or the antitrade above.

Second, the northwesterly movement at Izaña is dominant throughout the year, even when the trade wind stream is either not present below or is very weakly developed.

Third, the velocity of the northwest wind is strikingly great. If this velocity were the result of the transfer of mass between trade and antitrade, one would expect a low velocity in the boundary region; but, according to the observations at Izaña, the velocity of the northwest wind is at least as great as that of the trade on the open sea.

These three items are not proof that Sverdrup's and Wenger's conclusion is incorrect, but merely indicate a certain difficulty in accepting them. I personally incline to the belief that this strong flow from the northwest, since it is present throughout the year, constitutes the chief member of the trade-wind system in the region of the Canaries, provided always that this northwest wind is as frequent and strong in the free air as it is at Izaña. That the northwest wind is but poorly shown by the movements of the Cu and N clouds, agrees well with the conception that this wind, so far as it is to be called a part of the trade-wind system, is a descending wind in which clouds can neither form nor exist. Only in connection with the forward thrusting of cold air masses can the trade wind temporarily function in cloud formation,[2] and to such disturbances may be ascribed the fact that over 14 per cent of the Cu and N over Cañadas come from the northwest. As to the Cu and N in general, their formation takes place here only under the influence of atmospheric disturbances, when the trade is temporarily displaced by them.[3]

[3] The true "trade wind cumuli" as a rule float at a lower altitude than Cañadas and are therefore not involved in this consideration.

[2] See also Knoch, R., in Publ. no. 335 of the Prussian Meteorological Institute (Berlin, 1926). Under the title: "Rainsqualls of the Atlantic Trade Wind Region," this material was presented in a note in Mo. Wea. Rev., April, 1926, p. 167–168, by B. M. Varney.

WEATHER AND HAY IN NEW YORK STATE

By W. A. MATTICE

[Weather Bureau, Washington]

In an important dairy State, such as New York, hay necessarily plays a prominent part in the prosperity of the community. Next to dairy products in point of value comes hay, the total hay crop being worth well over $96,000,000. The tremendous value of this crop in comparison with the better known grain crops, such as corn, wheat, oats, and barley, makes it of great economic importance, and any weather factor which influences production is reflected in the well being of the State.

It has long been known that ample moisture is of great importance to hay, and the period which affects the yield most has been determined as the spring months. Temperature is of only secondary importance, as well moistened soil will usually promote favorable growth within a rather wide range of temperature conditions.

Smith (*1*) found that May rainfall was the most important factor in hay production, and further that in New York State normal rainfall was most favorable. In this connection he states that the hay crop apparently does not utilize much more than normal rainfall. I have made a series of correlations for the period 1894–1923 to check this observation and to attempt to find a more definite relation between weather and yield. The coefficients of correlation for the various months from April to July are given in the following table:

	April	May	June	July	August
Precipitation	0.34±0.11	0.36±0.11	0.42±0.10	0.14±0.12	0.13±0.12
Temperature	−.28± .11	−.44± .10	−.39± .10	−.05± .12	

These results show that June rainfall and May temperature exert the greatest influence on the yield.

This single series of coefficients was not sufficiently satisfactory, so various months were combined and it was found that the May and June mean temperatures and April to June precipitation were of much greater importance than temperature or precipitation for any single month. The coefficient for May and June temperature was -0.60 ± 0.08 or over seven times the probable error, and the April to June rainfall coefficient was 0.68 ± 0.07, or over nine times the probable error. These coefficients are sufficiently high to indicate a very definite relation between the weather variables and yield.

Figure 1 shows graphically the relation to yield of certain combinations of temperature and rainfall conditions, such as cool and wet, cool and dry, warm and wet, and warm and dry, the plus signs indicating yields above normal and the minus below normal.

Whenever the spring weather was warm and dry, hay was seriously affected. In fact, every time that warm, dry weather prevailed in this period the yield was below normal. Whenever it was either warm and wet, cool and wet, or cool and dry the hay yield was not seriously reduced, because the usually ample moisture offset possible adverse temperature effects.

The results of this charting prompted an attempt to use the multiple correlation method described by Wallace (*2*). This gives a coefficient of 0.85 ± 0.03, or a coefficient 28 times the probable error, showing conclusively a very definite and close relation. The inclusion, in addition to these factors, of the seasonal precipitation increased the coefficient to 0.87, but this is probably not of much value as the April to June rainfall had been included already.

The regression equation for the two variables and the yield was: $\overline{X} = -.05A + .06B + 3.62$, where A is the May and June mean temperature and B the April to June rainfall. The computed and actual yields in tons per acre for the period under consideration are given below.

Years	Computed yields	Actual yields	Difference
1894	1.22	1.17	0.05
1895	.91	.73	.18
1896	.88	.81	.07
1897	1.31	1.35	.04
1898	1.24	1.40	.16
1899	.93	1.04	.11
1900	.90	.81	.09
1901	1.34	1.30	.04
1902	1.39	1.34	.05
1903	1.23	1.26	.03
1904	1.13	1.36	.23
1905	1.23	1.30	.07
1906	1.21	1.28	.07
1907	1.49	1.25	.24
1908	1.16	1.20	.04
1909	1.24	1.05	.19
1910	1.35	1.32	.03
1911	.90	1.02	.12
1912	1.29	1.25	.04
1913	1.13	1.14	.01
1914	1.23	1.20	.03
1915	1.17	1.30	.13
1916	1.45	1.62	.17
1917	1.52	1.46	.06
1918	1.16	1.25	.09
1919	1.19	1.40	.21
1920	1.21	1.25	.04
1921	1.02	1.01	.01
1922	1.37	1.40	.03
1923	1.14	1.36	.22

The average yield per acre was 1.22 tons. The largest deviation from actual yield was 0.24 ton per acre, and the smallest 0.01 ton per acre, thus the extreme deviations ranged from 480 pounds to 20 pounds per acre. The standard deviation of yield was 0.19 ton, while the average departure of computed yield from the actual was only 0.10 ton, a reduction of 0.09 ton, or about 47 per cent. The average departure of 0.10 ton means nearly 500,000 tons for the State, or about 8.2 per cent of the total production.

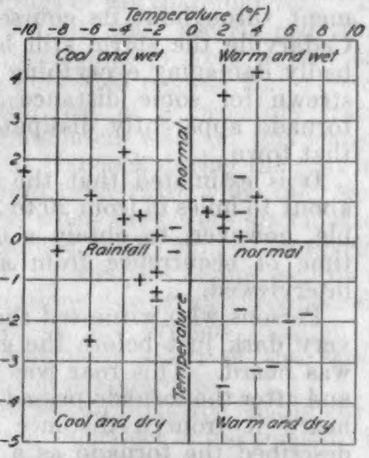

FIG. 1.—Relations between the yield of hay and certain rainfall-and-temperature combinations

SUMMARY

The weather of the spring months is the most important in hay production in New York State, and no single month is as important as a combination of months. The most important factor is the rainfall from April to June, inclusive, and the second in importance is the May to June mean temperature. The estimate of yield as computed from weather factors still leaves something to be desired, but averages 47 per cent closer than the deviation of yield from the average.

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THE TORNADO IN SOUTHERN MARYLAND, NOVEMBER 9, 1926

By THOMAS R. BROOKS
[Forecast Division, U. S. Weather Bureau, Washington]

[EDITOR'S NOTE.—The writer of this report made two trips to the scene of destruction. He was accompanied on the first trip by Mr. Arthur J. DeMars of the Forecast Division, and on the second by Mr. William C. Haines of the Aerological Division. The report is based on facts observed by these three gentlemen.]

A tornado, intense enough to cause the loss of 16 lives and almost complete destruction wherever it touched earth along a 15-mile path, occurred on the afternoon of November 9, 1926, in southern Maryland. Its known path was from a short distance southwest of La Plata in Charles County to beyond Cedarville, 14 miles away in the adjoining county of Prince George.

The general movement of the storm was almost directly northeastward across a gently rolling and for the most part wooded country varying in elevation from about 140 feet above sea level at the bed of streams to a little more than 220 feet on the hilltops. Judging from the wreckage, however, the vortex swayed from side to side as it progressed, there being many curves and abrupt changes of direction in its path, especially where the ground was uneven.

For nearly a mile at La Plata the tornado path was plainly visible. Four dwellings, a schoolhouse, and several substantial barns at this point were completely demolished, having been in every case lifted from their foundations and dropped as shattered débris to the ground. At several places between La Plata and Cedarville, visited by the writer, the destruction of buildings and uprooting and breaking of trees along a narrow path showed conclusively that the tornado did not lose its intensity nor change materially its direction of movement throughout its course. When it passed through Cedarville the storm still had full force, destroying or badly damaging everything in its path. Wreckage was strewn for some distance beyond Cedarville, but the tornado apparently dissipated a short distance beyond that town.

It is estimated that the storm moved a distance of about 15 miles in from 20 to 25 minutes. It was impossible, however, to obtain a definite statement regarding time of occurrence from any of the many witnesses interviewed.

Persons who witnessed the storm state that it became very dark just before the grinding roar of the tornado was heard. This roar was heard for some time before and after the tornado passed. One person reports having heard it from a distance of 3 miles away. Several described the tornado as a funnel-shaped cloud accompanied to a considerable height by whirling débris. Torrential rain occurred at the time of its passage. Little thunder was heard. Hail is said to have fallen at some places, but no evidence of it was found. Trees, débris, and houses on either side were mostly blown inward toward the center of the tornado but also forward, thus making an angle with the path. Trees and houses near or in the center of the path were carried straight forward in the direction of storm movement. A few trees at the edges were blown at right angles across the path. Another peculiarity noted was that the mass of wreckage of the schoolhouse at La Plata and trees surrounding it had been blown slightly toward the direction from which the storm approached.

At some places the tornado passed completely over the tops of trees, at other places it furrowed into the soil. Many fallen trees showed signs of having been twisted off and some tree tops were definitely twisted in an anticlockwise direction.

Clothing was stripped from bodies, and chickens defeathered. Heavy timbers were strewn for thousands of feet, and parts of desks from the La Plata school were found 7 miles away.

A letter from Mrs. R. B. Ellershaw, jr., Annapolis, R. F. D., contained the information that a piece of galvanized roofing 8 by 2 feet, bearing the name Mathews Howard (Inc.), La Plata, Md., fell in a farmyard 6½ miles from Annapolis and *about 50 miles from La Plata.* Mathews Howard (Inc.) state that they furnished the roofing for the schoolhouse at La Plata and that most of their sales were made around La Plata and south of that place and that they had never sold roofing to anyone very far north of it. Therefore it seems safe to conclude that this piece of roofing was carried aloft either from the schoolhouse or some other building in the tornado path.

Of the 16 persons killed, 13 were children caught in the collapse of the school. About 40 other people were injured, some severely.

A farmer who was in his home near La Plata when the tornado struck, told of a heavily timbered barn in his yard, 40 feet from where he stood at a window, being carried away without his knowledge, so dark had it become and so loud was the roar of the tornado. After it had passed him, he saw the tornado destroy a house 800 feet away and likened the spectacle to a great explosion of black gunpowder. This house was a little to the left of the center of the tornado path.

The statement of Miss Ethel Graves, a teacher at the La Plata school, is of unusual interest. She was evidently whirled about in the vortex while still conscious.

> It was just a few minutes before 3 o'clock that I heard a rumbling roar and the wind seemed to increase tremendously. I was just getting ready to take the children to some safer place when the glass from all the windows blew out. The children had started toward me then and were beginning to group themselves about me when suddenly it seemed as if they and everything in the room about me had been pulled up by some unseen hooks. Then we were all flying through the air. It seemed to me as if some of the children and parts of the building passed me several times. I lost consciousness then.

At the time the tornado occurred weather over the eastern United States was under the influence of a low-pressure area of considerable intensity that during the 12 hours beginning at 8 a. m. passed northeastward from central Indiana to extreme southern Ontario. East of a trough that extended southward from its center, and over the region through which the tornado passed, the general air movement was from the south and southwest at the surface and from the southwest aloft up to a known elevation of 2,000 meters. Above Washington, 28 miles from La Plata, at 3.24 p. m., at 1,710 meters elevation, the wind was blowing from the southwest at 24 meters per second. The wind shift associated with the passage of the trough above referred to did not reach Washington until 10 p. m., at which time the wind began to blow strongly from the north-northwest at the surface and aloft to at least 4 kilometers. This change in surface wind direction, it will be noted, took place about 10 hours after the occurrence of the tornado.

Conditions during the afternoon seem to have been favorable for very active convection locally along the Atlantic coast, as thunderstorms were general, and a thunderstorm with excessive precipitation (0.65 inch in nine minutes) occurred at Washington about the time the tornado passed La Plata.

EFFECT OF LOCAL INFLUENCES IN MODIFYING THE GENERAL ATMOSPHERIC CONDITIONS[1]

By ALFRED SMITH

[Assistant Professor of Soil Technology, University of California]

Central Wisconsin soils are mainly light texture, being mainly sands, while north and south of this area the soils are heavier, being mainly silt loams. A statistical study was made of the rainfall and temperatute data obtained by the United States Weather Bureau at many stations to ascertain if the sandy nature of the soils in central Wisconsin exerted any marked influence on these two climatic factors.

In 1906 A. J. Henry referred to a 4-inch smaller annual rainfall in the vicinity of the Winnebago basin as compared to surrounding points, and emphasized the fact that this was based on only a 10-year period of observation, which he considered too short to determine whether this discrepancy was actual or only apparent.

The records first used in this analysis were for stations in and out of the sandy area from the time of the establishment of the Weather Bureau stations to 1920, inclusive. The rainfall records were compared by taking the total annual, April to September, or the growing season, and also just for the month of August, as it is thought by some that during this month the weather in Wisconsin is less subject to the influence of cyclones or thunderstorms. No consistent differences were found to have taken place in and out of the sandy area. One reason for this is the shortness of the records and the occasional heavy rainfall which may come at just one of the stations. As an illustration, in June, 1914, at Hancock in the sandy area the total precipitation was 11.75 inches, while at Madison in the silt loam area to the south it was 3.46, and at Merrill in the silt loam area north of Hancock it was 7.10 inches.

In comparing the temperature records for stations in the silt loam areas north and south of the sandy area with those in the sandy area from the time of the establishment of the stations to 1920, inclusive, it appeared at first that the temperatures were higher in the sandy area than one would expect to be the case, i. e., they were nearer to those of stations lying south of it than to those of stations which were practically the same distance north of it.

The stations chosen in the sandy area were Hancock, Wisconsin Rapids, Stevens Point, Meadow Valley, Mather, Valley Junction, and Hatfield, and the length of the record for these varied from 17 to 28 years. The only one of these stations where there was a wide deviation in the mean monthly temperature was at Mather. The mean annual temperature at Mather was 42° F. and at Hancock 44.4° F., while at the other stations it varied from 43.3° F. to 43.7° F. The lower temperature at Mather was due, no doubt, to the fact that this station is located in a swampy area.

[1] Author's abstract of Part 2 of a thesis submitted at the University of Wisconsin in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The author wishes to express his appreciation for the helpful suggestions and criticisms tendered by Prof. A. R. Whitson.

In comparing the temperature data of one station with those of another in this work, corrections were always made for differences in altitude.

As the nature of the soil is likely to have an influence only during those months when there is no snow cover, a further study was made of the temperatures during the growing season, April to September, inclusive. On this basis the sandy area when compared with the silt loam areas had no marked temperature differences when allowances were made for differences in latitude. In comparing the mean August temperatures, the sandy area seemingly had a higher temperature than what would be considered the mean.

The next comparison was made by selecting stations in the sandy area with those in the same latitude in Minnesota, where the soils in general are heavier. The records for the years 1913–1919, inclusive, were used, for during this period, according to the records the thermometers at the stations selected were not moved. The temperature for the growing season and the departures from the latitude mean were determined and corrections made for differences in altitude. The temperatures during the growing season at Hancock, which is located in the more typical portion of the sandy area, were on this basis above the latitude mean. This was also true for the mean maximum temperatures as well.

It appeared after these studies that due to the varying results perhaps detailed information was lacking relative to the immediate surroundings of the thermometers. By personal visit to Hancock it was ascertained that between 1910–1921 the thermometers were not at the location referred to in the published records, but were on a sheet-iron lean-to at the rear of a two-story frame building. While the thermometers were on this lean-to the average temperatures at Hancock during the growing season were higher than from 1905–1910, when they were over sod, or from 1922–23, when they were also located over sod. This was determined not by simply comparing the data for Hancock, but by analysis of the records at other central Wisconsin stations during all three periods.

With the thermometers at the present location at Hancock over sod no appreciable effect of the sandy nature of the surrounding soil is apparent.

If the conditions of sandiness and relative lack of cover do affect temperature at all, the effect is too small to be shown in the observations made by the Weather Bureau. If it were possible to place thermometers with greater care and with better location for the purpose it might be possible to show a small effect of soil texture. No effect that the sandy nature of the soil might have on the rainfall of this section can be detected in the data that is at present available.

NOTES, ABSTRACTS, AND REVIEWS

A COMPARISON OF HYDROLOGICAL AND METEOROLOGICAL DATA

By Prof. V. I. PETTERSSON

[Condensed from Meteorological Magazine of October, 1926]

Professor Pettersson in a lecture at the reunion of the International Council of Exploration of the Sea in September, 1925, in Copenhagen[1] compares the hydrographical statistics of the surface temperature of the sea for the 14 years 1900–1913, with meteorological data for the same period. It is shown that there exists a fair relation between the mean annual air temperature of oceanic islands, such as Madeira, and the surrounding ocean, a correlation coefficient of +0.86 being obtained for the values for Madeira and the sea some 35 miles to the northeast.

The path of the Gulf Stream was studied by reference to the temperature of adjacent sea areas, whence it appears the Gulf Stream drift divides south of Newfoundland into two portions, one going to the north toward Greenland, and the other to the east (south of 40°) to the west coast of Europe. It also appears that the northerly branch has a seasonal flow, the excess temperature over surrounding areas disappearing in January.

The Gulf Stream itself shows variations of temperature from year to year but the correlations of these variations with the temperature of western Europe is nil.

Professor Pettersson estimates the annual variation of the amount of melting ice by comparing the average departure of the water temperature from the mean temperature in the summer months to the east of Newfoundland. The warmer or colder surface water spreads eastward from this zone of melting ice, as part of the Atlantic drift current to the shores of Europe. It is estimated that this water will arrive 12 or 14 months later. The correlation coefficient between the surface temperature in summer of the area in which the ice melts and the mean annual temperature of the water in the ocean midway between Newfoundland and Ireland in the following year (i. e., six to eight months later) is found to be +0.45.

The variations of the mid-Atlantic temperature are reproduced in the variations in the rainfall of Ireland in the following year, a correlation coefficient of +0.64 being obtained from the data for the years 1900–1913. It is further shown that the general rainfall values for Ireland, Great Britain, Spain, and Sweden are very similar. Thus there is some evidence for suggesting that the rainfall of western Europe is determined by the temperature of the sea on the other side of the Atlantic one or two years earlier.

Professor Pettersson points out that this is a preliminary discussion and that larger series of observations and more accurate measurements of the water temperature by automatic recording instruments are required.—*A. J. H.*

TEMPERATURE RELATIONS BETWEEN CERTAIN MONTHS IN DIFFERENT YEARS

In *Comptes Rendus* for November 8, 1926, page 802, Louis Besson presents the results of calculations bearing on this matter. By plotting the sums of the accumulated monthly departures from normal of April and of July, with the July values on the same abscissa as the April value seven years previous, for Paris, the author obtains two curves which in their broad features show remarkable parallelism. The correlation coefficient stating this relation is 0.817 ± 0.021.

Computing the correlation coefficient between the actual monthly means, April of a given year and July seven years later, 0.404 ± 0.052 was obtained. Calculation shows that the chance of this relation being fortuitous is but one in a million. The relations have persisted throughout the 117 years of record analyzed. For the first 48 years, $r = 0.458 \pm 0.077$, and for the 69 later years $r = 0.362 \pm 0.071$.

The lag of 7 years was determined upon after calculation of the coefficients between April and July means for lags of 0 years to 9 years showed the maximum difference of phase at 7 years. A strong departure in April has usually been followed by a strong departure of the same sign in July seven years later.

The relation indicated for Paris is still more striking for Strasbourg and almost as much so for Nantes. It is present at Vienna, but toward the north it fades out rapidly, and even more rapidly toward the south.

Two less pronounced relations also emerge from the Paris record, namely, that May temperature varies, in its broad outlines, as that of December eight years before, while November temperature varies inversely as January temperature six years before.—*B. M. V.*

DISTRIBUTION OF HUMIDITY IN THE ATMOSPHERE

W. KHANEWSKY

[Reprint of Science Abstracts No. 2548, sec. A, Physics, November 25, 1926]

(Met. Zeit., 43, pp. 253–256, July, 1926).—From the published aerological soundings on international days, 1905–1912, values have been extracted and annual means calculated for the relative humidity up to 20 kilometers over Hamburg, Lindenburg, Uccle, Strasburg, Munich and Pavia. Mean values for all six stations are also found, and it is noted that for all parts the relative humidity, r, decreases with height. Between the surface and 3 kilometers the mean decrease is 37 per cent in winter, 35 per cent in autumn, 16 per cent in spring, and 13 per cent in summer. It was considered possible to separate four zones: (1) Surface, 1 kilometer, where the condensation processes are most frequent; (2) 1 to 4 kilometers, with condensation processes less frequent, less vapor and smaller temperature gradient; (3) 4 to 11 kilometers, with a balance between the ordinary decrease of r with height and the large temperature decrease, and thus r is almost constant; and (4) above 11 kilometers, where temperature begins to rise, but results do not show an increase of r. Hergesell's formula for the change of r with height applies only to the second zone. A preliminary survey was made for the variation of r with height in different parts of an anticyclone and a depression. For the latter r decreases at very different rates in the several quadrants. Finally, absolute values are calculated for r, and the temperature for five stations, and these values tabulated for all heights up to 10 kilometers. The greatest change occurs from the surface to 2 kilometers, while above 5 kilometers the change is very slow, as values are so small. A comparison of these results with those calculated from formulae given by Süring and by Hergesell shows that the former's expression is more accurate.—*R. S. R.*

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[1] Etude de la Statisque Hydrographique du Bulletin Atlantique du Conseil International pour L'Exploration de la Mer. Svenska Hydrog.-Biol. Komm. Skri. New Series. No. 1 Göteborg, 1926.

A NEW DEEP-SEA THERMOGRAPH—MOLTSCHANOFF SYSTEM

Annalen der Hydrographie und Maritimen Meteorologie of August 15, 1926, contains a description and diagram of this instrument. A fundamental difficulty with former types of deep-sea thermograph has been the impossibility of keeping sea water out of the housing of the registering apparatus. The trouble lay with the connections between the thermal element outside of the housing and the register inside. Any connecting rod had to pass through a stuffing box. And no thermal element was powerful enough to work a rod through a stuffing box tight enough to keep out water under deep sea pressures. The new device is intended to remedy all this.

Its thermal element is a brass tube of small diameter, sealed water-tight at both ends, mounted outside of and parallel to the heavy cylindrical register housing, to which it is attached at the middle of both tube and housing by a short, water-tight hollow fixture giving free access from the interior of one to the interior of the other. Within the tube are two light invar-steel bars. These extend, respectively, from fastenings near the ends of the tube to a movable joint opposite the opening in the hollow fixture just referred to. From this joint a rod passes through the fixture to a train of levers leading to the pen on the registering drum.

The ingenious new feature in Moltschanoff's device lies in using the expansions and contractions of the brass tube with its high coefficient of expansion, to move the invar-steel bars which have a coefficient very close to zero.

The depth of submergence of the instrument is obtained by utilizing the hydrostatic pressure in a bourdon tube mounted with open end through the main register housing, the inner end being connected with a lever train to a pen on the recording drum.—*B. M. V.*

EARLY METEOROLOGY IN GERMANY

G. Hellmann, continuing his research into the beginnings of meteorological observation in Germany, has been able to set back the date of the supposed earliest records (Stoffler's *Almanach nova*, 1499) to *Ephemerides* by one Regiomontanus from 1490. This work contains for each month for the years 1490–1505 two pages of weather notes entirely in Latin except for two entries of "hagel" and one, for January 20, 1501, of "eyn grosz waszr"—a similar occurrence in February, 1491, having been noted as a "diluvium." The above are items from the section on "Pre-instrumental Meteorological Observations" in a fascinating historical survey by Hellmann entitled "The Development of Meteorological Observations in Germany from their Beginnings to the Establishment of the National Observing System" (issued by the Academy of Sciences, Berlin, 1926).

With encyclopedic thoroughness the author has assembled and briefly characterized all the known sources of observational material. The noninstrumental period extends from 1490 to 1678. The first decade which the author describes as having "active meteorological stations" was that of 1701–1710. There were six stations in that decade. Through various periods of increase and decrease the number rose to 67 for the decade 1781–1790, but fell off to 20 for 1801–1810. Thereafter, however, the growth of stations was continuous, and in the decade 1841–1850 there were 169.

October, 1847, saw the establishment of the national service, the Prussian Meteorological Institute.—*B. M. V.*

PROGRESS IN INTERNATIONAL METEOROLOGY

The most recent meeting of the International Meteorological Committee was held in Vienna, September 23–28, 1926. To this meeting, eight of the commissions appointed by the committee presented some 70 resolutions looking toward further cooperation between the nations in meteorology, the commissions having been in session from September 13 to 20, in Zurich.

Progress is indicated in the adoption of an international code for day and night visual gale warning signals; in the definitive fixing of wind velocity equivalents to be used in translating anemometer velocities into Beaufort velocities for weather telegrams; in the preparation of an international cloud atlas embodying changes in cloud nomenclature and a new set of photographs. This will be submitted for the approval of the International Conference of Directors in 1929, and will take the place of the 1895 atlas of Hildebrandsson, Riggenbach, and Teisserenc de Bort.

The work of the International Meteorological Committee has outgrown the stage in which the labor of its secretarial and publishing work could legitimately be imposed on some one of the national meteorological services. A committee of three has therefore been put to work upon the problem of setting up a permanent secretariat. This secretariat will take over the records of the conference and of the international committee and its commissions, will arrange the meetings, see to all publication, and act as a clearing house for meteorological information of interest to the State services concerned.—*B. M. V.*

MORE "BLOOD RAIN"

La Nature for November 27, 1926, prefaces an account of a "blood rain" in France on October 30, 1926, with a brief historical résumé. We quote the following from this account:

> It was not until 1669, on the 17th of March, when a "blood rain" fell at Chatillon-sur-Seine, that the truth began to be suspected. "There fell in various parts of the city," says the History of the Academy of Sciences, "a sort of rain, or reddish liquid, thick, viscous, and stinking, which resembled a rain of blood. The prints of great drops of it were observed on walls; it was this fact which led to the belief that this rain was made of stagnant, muddy water, raised by a whirlwind from some pond in the neighborhood." * * *
>
> There have been observed many red and yellow rains, especially in southern France, southern Italy, the Balkans, and Turkey. * * * The Saharan simoom, and the sirrocco, are quite capable of raising tons of these particles. On the Canary Islands, the soil of which is essentially volcanic, there are observed sand dunes formed of deposits which east winds have brought from the African deserts. In 1846 a mud rain accompanying a series of thunderstorms and violent squalls fell over France, Italy, and in Turkey. It covered the Jura and the south of France with a thick deposit. In Valence the layer was so thick that people had to clean their roof gutters and disconnect the down-spouts. The Chateau of Chamagneu received a coating that rendered it almost unrecognizable. We find similar rains in 1847 at Chambery, and in 1862 in central France, in 1863 a snow which was thought to be colored with blood, as also on March 10, 1869, February 13, 1870, etc. * * *
>
> Of the same sort was the rain which fell on the 30th of October last, about 6.30 p. m. On the following morning the inhabitants of Isle-sur-Serein were astonished to find that the rain storm which had been raging all night had left an earthy deposit, reddish in color and oily to the touch. In the troughs for catching water from the roofs the water was muddy and rust-colored; clothes left out by washerwomen were stained a muddy russet and had to be put back in the wash. * * * The deposit was somewhat like powdered cacao. Under the microscope it showed that it was composed of tiny semitransparent crystals and of a rather glistening dust in a clayey matrix. * * *

It may be pointed out that on the 24th of October a violent southwesterly storm, accompanied by thunder squalls, raged for 48 hours. It marked the onset of a cyclone which arrived over French territory, moving about south-southeast. The apparatus at the Observatory of Guette registered, from midnight of the 25th to 6 p. m. of the 26th * * * the passage of 710 kilometers of wind, with velocities up to 20 meters per second, or 75 kilometers per hour. After three days of lull, a new storm * * * with *violent south wind*, brought, on the 30th of October, the curious colored rains noted in our territory. * * *

The water in this rain, when evaporated, left a deposit of 5.75 milligrams per liter, or for each 10 millimeters of rainfall 57.5 milligrams per square meter, or 575 grams per square hectare [2.471 acres]. When one considers that the Department of the Yonne has an area of 746,006 hectares [3,036.5 square miles], that means over 525 tons of solid matter left by the rain over this region alone.—*B.M. V.*

LIGHTNING OUT OF A CLEAR SKY

[Extracts from a communication by H. J. Upham, Panama City, Fla.]

Referring to MONTHLY WEATHER REVIEW, August, 1926, p. 344, note on "Lightning out of a clear sky," B. M. V. quotes Florida conditions. I have noticed this dangerous lightning ahead of a summer squall so frequently during my three years' residence here, about 5 miles east of Panama City [some 45 miles northwest of Appalachicola—ED.] that I am more apprehensive of it than of lightning in the squall, as one is more apt to linger out of doors. We have a summer condition of squalls forming northeast, east, and southeast of us. * * *. Day after day the squalls will build up east of us with a general northerly movement, but some movement or building up westerly, toward us. There will be no squall condition west of us noticeable. These squalls miss us day after day at times, but come close enough for us to get the ground out of a comparatively clear sky. I have noticed this so frequently that I watch the squalls for this phase, when working in the grove. I have recognized it but not closely enough to study the position of the lightning in the cloud or how far ahead the ground occurs. I rather feel it occurs in the building up phase and when there is a slight haze and possibly detached clouds in the sky. It is a ground, though, and not from cloud to cloud. I have not noticed any connection between it and whether we will get the squall or not.

PHYSIOLOGICAL EFFECTS OF CLIMATE

The climatologist, the physician, the geographer, all interested in the relations of climate to man, will find a useful presentation of present-day results and views regarding "The Physiological Effects of Climate" in a paper under that title by Otto Kestner, received at the Weather Bureau library as a separate from the *Handbuch der Normalen und Pathologischen Physiologie* (press of Julius Springer, Berlin).

The paper is a condensed summary (50 pages) of a considerable range of literature on the subject—the extensive citations referring mostly, however, to German authors. The variety of climatic factors dealt with in their relations to health is evident from the following list of major divisions of the work:

Temperature, moisture, wind direction and velocity, winds of the foehn type, barometric pressure, varying partial oxygen pressure and carbon dioxide pressure, light, ultra-violet radiation, consideration of ionization of the atmosphere, and of other factors not yet investigated.—*B. M. V.*

TORNADOES OF NOVEMBER 25-26, 1926

Accompanying a cyclone of considerable intensity which moved northeastward from the Middle Plains to the Great Lakes on Thursday, November 25, a series of tornadoes occurred over Missouri, Arkansas, Louisiana, Mississippi, Tennessee, and Alabama, in which 88 lives are known to have been lost and 200 or more persons injured, aside from property damage which runs into many thousands of dollars.

Two of this series of tornadoes occurred in southern Missouri. The first struck near Competition, Laclede County, about 5 p. m., and, moving northeastward into Phelps County, took a toll of two lives and injured 11 persons. Its path ranged from 100 yards to half a mile in width and was about 50 miles in length. Considerable damage to buildings of all kinds and crops resulted, and much livestock was killed or injured.

A little over an hour later, or about 6.20 p. m., the second tornado occurred. Beginning at Brandsville, Howell County, near the Missouri-Arkansas line, it moved northeastward into Oregon County over a path about the same width as that of the preceding storm and was last seen near Thomasville about 14 miles away. The property damage from this tornado was considerably greater than the earlier one; four lives were lost and about 40 persons injured.

Arkansas paid the heaviest penalty in lives lost as well as in destruction of property. Here tornadoes occurred at a number of widely separated points. The chief one traversed Faulkner and Cleburne Counties, doing a great amount of property damage in and about Heber Springs, where it took a total of 22 lives and injured many persons.

A storm of like character struck Perry County about 6.30 p. m. and advanced into Conway County, and one also occurred in Pope and Van Buren Counties. These, however, were less severe, the first taking five lives and the second eight. Heavy property losses resulted from both storms. Storms of a more local character occurred near Newport with 2 lives lost, and at Sheridan with 1, Macedonia 2, and Moscow 10. In all, the tornadoes in Arkansas cost 50 lives, and a great amount of property damage, which has not yet been fully estimated.

About 8.45 p. m. a tornado of great intensity struck in the vicinity of Haynesville, Claiborne Parish, La. Its path averaged 67 yards wide and although it only covered 14 miles, damage of more than $100,000 is reported with a loss of seven lives.

About 11.30 p. m. and 80 miles east of the Haynesville tornado the second Louisiana tornado occurred in Morehouse Parish near the vicinity of Mer Rouge. The path was about 100 yards wide and ran northeast about 4 miles. Here 11 persons were killed, 38 injured, and property loss was considerable.

Northeast of the Louisiana storms, a violent wind having tornadic characteristics occurred near Marks, Miss., where 10 persons were killed, a number injured, and many unsubstantial buildings damaged.

The high winds on the night of the 25th–26th in west Tennessee took the form of a tornado at Florence early on the morning of the 26th. Here little damage was done; the path was short and about 200 yards wide.

At 5.30 a. m. of the 26th the last of this series of violent storms occurred about 1 mile north of Winfield, Ala., doing considerable property damage and causing the loss of four lives. Here the path was 150 yards wide and 7 miles long.

Tornadoes in November are more or less infrequent, and the above appear to have been among the worst that have occurred during that month.—*Grace W. Carter.*

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, OCTOBER, 1926

By J. B. NAVARRETE, Director
[Observatorio del Salto, Santiago, Chile]

During October, 1926, the atmospheric changes were limited to the southern part of the country, and in the meantime in the central zone the weather was settled and hot.

Important atmospheric depressions crossed the far southern region and produced bad weather and rains over southern South America between the 1st and 4th the 8th and 12th, and again toward the end of the month, 28th to 31st. The heaviest precipitation in 24 hours was registered on the 2d at Valdivia, 50 millimeters.

Between the 5th and 7th and from the 13th to 27th two important anticyclonic centers were built up over the southern region, causing generally fine weather, but with high winds in the south between the coasts of Chiloe and Arauco Provinces. These winds reached a velocity of 1,000 meters per minute (37.4 m. p. h.) and caused frequent heavy surf on the coasts of the southern Provinces.

Rains were limited to the southern area included between Concepcion and Chiloe Provinces.—*Transl. B. M. V.*

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Dissertazione prima sopra un fenomeno volgarmente detto fata morgana, O sia apparizione di varie, successive, bizzarre immagini, che per lungo tempo ha sedotti i popoli, e dato a pensare ai dotti a sua eminenza il signor cardinale de Zelada. Roma. 1773. xx, 104 p. plate (fold.) 20 cm.

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The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

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American meteorological society. Bulletin. Worcester, Mass. v. 7. 1926.

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[**Peppler, W.**] The future of aerology. p. 123–125. (Oct.) [Transl. from Das Wetter.]

Vivian, C. H. Snow removal on Fall River Pass highway, Colo. p. 127–129. (Oct.) [Extr. Engineering news-record.]

Alter, J. Cecil. An appreciation of the cooperative observers. p. 165–166. (Dec.)

Excessive rains and floods in Illinois, September, 1926. p. 167. (Dec.)

McEwen, George F. Indicated seasonal rainfall in Southern California for the 1926–1927 season. p. 161–162. (Dec.)

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Besson, Louis. Relation entre les températures de certains mois de l'annee. p. 802–804. (8 novembre.)

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1926

By HERBERT H. KIMBALL, Solar Radiation Investigations.

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, **52**:42, January, 1925, **53**:29, and July, 1925, **53**:318.

From Table 1 it is seen that solar radiation intensities averaged close to the November normals at all three stations.

Shortly after 9 a. m. on the 12th a dense smoke cloud passed over the American University, D. C. Although of but brief duration considerable absorption of solar radiation occurred as is shown by the values of 1.08, 0.56, and 1.08 gram calories obtained at air masses 3.0, 2.5, and 2.0, respectively. Atmospheric dust and sulphur content measurements made during the passage of the cloud show a three-fold increase in the number of dust particles and about double the sulphur content that was found at 8 a. m. Therefore most of the smoke cloud passed over the University instead of enveloping it, as was the case with the cloud of April 7, 1925, and which was described in the REVIEW for April, 1925, p. 147–148.

Table 2 shows a deficiency in the amount of radiation received on a horizontal surface from the sun and sky at all three stations for which normals have been determined.

TABLE 1.—*Solar radiation intensities during November, 1926*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Nov. 1	4.57	0.90	1.02	1.16	1.32	1.46	0.92	1.00	0.93	0.83	3.45
2	3.81	0.88	1.02								3.63
4	3.99				1.04						2.87
5	4.75			0.92	1.12		1.14	0.93	0.80	0.68	3.99
6	4.57	0.72	0.80	0.93	1.22		1.21	0.97	0.85	0.75	5.56
10	4.17	0.75	0.85	1.05	1.35						3.00
11	2.26	0.64	0.76	0.90							2.36
12	2.87	0.89	1.01	1.08	1.08			1.06	0.94		2.62
17	4.37	0.92	0.95	1.12	1.30			0.94	0.86		5.16
19	3.30		0.85	0.97							3.15
22	3.15	0.66	0.79	1.18				1.04	0.88	0.76	3.30
Means		0.80	0.89	1.03	1.20	(1.46)	1.09	0.99	0.88	0.76	
Departures		+0.05	+0.04	+0.03	+0.02		−0.07	+0.01	+0.05	+0.03	

TABLE 1.—*Solar radiation intensities during November, 1926*—Con.

[Gram-calories per minute per square centimeter of normal surface]—Contd.

Madison, Wis.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Nov. 5	3.45			0.92							4.75
10	1.88		1.16	1.29	1.43	1.59					2.06
11	1.68		1.03	1.15	1.29	1.45					2.06
24	2.74			1.19				1.02			2.87
Means			(1.10)	1.14	(1.36)	(1.52)		(1.02)			
Departures			+0.06	−0.01	+0.06			−0.14			

Lincoln, Nebr.

Date	8 a.m.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	Noon
Nov. 1	2.16		1.14	1.25	1.38	1.52			1.00	0.95	2.87
4	3.15	0.89	1.06	1.16	1.38			1.11	0.99	0.87	3.30
9	1.78	1.10	1.19	1.30	1.45	1.63					2.74
11	2.62	0.81	0.95	1.11	1.31		1.33				3.00
26	2.06	0.99	1.11	1.24	1.38	1.54					2.36
29	3.54		1.06	1.18					1.00	0.92	4.57
Means		0.95	1.08	1.21	1.38	1.56	(1.33)	(1.11)	1.03	0.91	
Departures		+0.02	+0.04	+0.02	+0.03	−0.01	−0.03	−0.08	−0.02	−0.03	

* Extrapolated.

At Washington skylight polarization measurements made on seven days give a mean of 62 per cent, with a maximum of 67 per cent on the 1st. At Madison, no measurements were obtained, as the ground was generally covered with snow on the days when the sky was clear.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
1926	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Oct. 29	202	153	243	94	154	−43	−34	−5
Nov. 5	210	194	205	149	136	−13	+25	−27
12	169	61	129	50	122	−30	−87	−86
19	175	126	184	66	110	−1	−8	−18
26	145	127	201	42	103	−13	+2	+13
Deficiency since first of year on Dec. 2						−1,188	−2,016	−3,353

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The North Atlantic HIGH and Icelandic LOW were both unusually well developed during the greater part of the month, and, in consequence, the number of days with winds of gale force was considerably above the normal over the eastern section of the steamer lanes. Gales were also reported on from two to three days along the American coast between Nova Scotia and Florida, and on two days in the Gulf of Mexico.

The number of days with fog was apparently less than usual; judging from reports, it occurred on from five to six days over the Grand Banks, and on from three to five days along the American coast, north of Nantucket, while the middle and eastern sections of the steamer lanes were comparatively clear.

26366—27——2

On the 1st an area of low pressure was central about 10° west of Malin Head, Ireland, accompanied by moderate to strong gales over the eastern section of the steamer lanes. This LOW moved northeastward, decreasing in intensity, and on the 2d and 3d moderate weather prevailed generally, except that on the 2d Julianehaab, Greenland, reported wind southeast, force 9, barometer 28.91 inches.

On the 4th an exceptionally severe disturbance was central near 50° N., 30° W., with winds of from force 10 to 12 in the southerly and westerly quadrants. The storm area was of limited extent however, covering only the region between the forty-fifth and fifty-first parallels and the fifteenth and thirty-fifth meridians. This LOW pursued the usual northeasterly course, and on the 5th was central off the north coast of Scotland; it had apparently

decreased somewhat in intensity, although on both the 5th and 6th land stations on the British Isles, as well as vessels in the vicinity, reported moderate to strong westerly gales.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian time), North Atlantic Ocean, November, 1926*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	[3] 29.26	([4])	29.69	17th	28.47	26th.
Belle Isle, Newfoundland	29.88	0.00	30.56	19th	29.08	11th.
Halifax, Nova Scotia	30.14	+0.14	30.64	14th [2]	29.66	10th.
Nantucket	30.12	+0.03	30.56	do	29.46	Do.
Hatteras	30.14	+0.02	30.46	12th	29.54	16th.
Key West	30.04	+0.01	30.20	22d [2]	29.84	7th.
Swan Island	29.87	−0.05	29.96	19th [2]	29.76	Do.[2]
New Orleans	30.16	+0.05	30.40	do	29.72	8th.
Turks Island	30.01	0.00	30.08	22d [2]	29.86	7th.
Bermuda	30.18	+0.10	30.36	29th	29.98	20th.
Horta, Azores	30.32	+0.20	30.54	28th	30.06	Do.
Lerwick, Shetland Islands	29.42	−0.28	30.16	29th [2]	28.47	14th.
Valencia, Ireland	29.53	−0.36	30.31	26th	28.54	20th.
London	29.61	−0.33	30.26	25th	28.51	Do.

[1] From normals shown on H. O. Pilot Chart, based on observations at Greenwich mean noon, or 7 a. m., seventy-fifth meridian.
[2] And on other dates.
[3] Mean of 23 observations; 7 days missing.
[4] No normal established.

On the 5th the barometric reading at Galveston, Tex., was 30.42 inches and at Swan Island, 29.86 inches. The resulting steep gradient was attended by a stiff "norther" in the Gulf of Mexico, as shown by report in table.

On the 6th a moderate depression was central near 55° N., 30° W., that drifted slowly eastward, increasing in intensity, and on the 11th was over the Irish Sea. This disturbance reached its greatest force on the 10th, when strong northerly to westerly gales swept the steamer lanes east of the twenty-fifth meridian.

On the 8th a well-developed LOW was central off the coast of northern Texas and southwesterly gales were reported by vessels in the western section of the Gulf of Mexico.

On the 11th a well-developed depression covered the Gulf of St. Lawrence, with moderate to strong gales as far south as the fortieth parallel.

On the 12th the second "norther" of the month was reported by vessels between the Bermudas and east coast of Florida, as shown by report in table from American S. S. *Yoro*.

On the 12th there was a comparatively slight depression near 53° N., 27° W., that afterward developed into a severe disturbance as it moved slowly eastward, and on the 13th and 14th westerly gales of almost hurricane force swept the steamer lanes east of the thirty-fifth meridian.

On the 14th Brownsville, Tex., was near the center of a moderate LOW that moved slowly eastward across the Gulf of Mexico, being central on the 15th near Pensacola. On the latter date moderate gales were reported by vessels along the coast between Hatteras and Jacksonville. Chart VIII shows this disturbance on the 16th, when the American coast between New York and Charleston was swept by southerly gales.

Charts IX to XI cover the period from the 17th to 19th, inclusive, when exceptionally severe weather prevailed over the eastern section of the ocean. The position of the LOW on the 20th and 21st differed but slightly from that of the 19th, although by the 21st it had begun to fill in, and on the 22d moderate weather was the rule over practically the entire ocean.

In addition to the storm report from the American S. S. *Endicott*, Captain Henderson, shown in table, the observer, Mr. Petersen, third officer, makes the following statement:

> The barometer registered 28.53 inches at 4 a. m. on the 20th, more than 24 hours after this blow had subsided. Barometer read below 29 inches until morning of the 21st. With these low readings of the barometer we had extra fine weather.

On the 23d a well-developed disturbance was central near 48° N., 42° W., with strong northwesterly gales near the center. This LOW apparently moved northeastward and on the 24th westerly gales were reported by vessels near 55° N., 30° W.

On the 25th Belle Isle was near the center of a LOW that took the usual northeasterly course, and on the 26th strong westerly gales occurred between the fortieth meridian and the coast of Greenland.

On the 27th and 28th the Province of Quebec was covered by an area of low pressure, attended by heavy weather along the American coast between Halifax and Hatteras.

On the 29th and 30th moderate weather was the rule, except that on the latter date northeasterly gales were reported by vessels near 38° N., 52° W., while a fresh northerly gale prevailed at the Scilly Islands.

OCEAN GALES AND STORMS, NOVEMBER, 1926

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Eibergen, Du. S. S.	South Shields	Sydney, N. S.	58 47 N.	14 40 W.	1	4p, Nov. 1	1	29.30	SE	SE., 5	SE	SE., 9	Steady.
Bremen, Ger. S. S.	Bremerhaven	New York	45 46 N.	42 07 W.	1	Mdt, 3	4	29.62	W	SW., 10	NW	SW., 10	W.-SW.
Elswick Park, Br. S. S.	Rotterdam	Baltimore	49 22 N.	32 45 W.	4	9a, 4	4	29.29	NW	NW., 12	NW	NW., 12	Steady.
Idaho, Br. S. S.	Antwerp	New York	49 25 N.	23 10 W.	4	4p, 4	5	28.93	W	W., 12	NW	W., 12	W.-SW.-NNW
Eibergen, Du. S. S.	South Shields	Sydney, N. S.	57 00 N.	25 11 W.	4	4p, 4	5	28.95	WSW	NW., 5	WNW	NW., 10	WSW.-NW.
District of Columbia, Am. S. S.	New York	Tampico	22 18 N.	96 21 W.	4	4p, 4	6	30.13	NNW	NNW., 9	NE	NNW., 9	NNW.-NE.
Western Ally, Am. S. S.	Norfolk	Rotterdam	49 09 N.	20 59 W.	4	6p, 4	5	29.20	SW	NNW., 11	WNW	WNW., 11	SW.-WSW.-WNW.
Bintang, Du. M. S.	Port Said	Boston	43 06 N.	43 06 W.	4	—, 5	5	29.56	E	SW., 9	WNW	SW., 9	—.
Pres. Harding, Am. S. S.	Cobh	New York	50 18 N.	23 45 W.	6	8a, 7	9	29.20	NW	WNW., 5	NNW	WNW., 10	—.
Stockholm, Swed. S. S.	New York	Gothenburg	58 18 N.	14 30 W.	7	4a, 7	8	29.33	NNW	W., 2	W	—, 10	W.-SW.-SSW.
Arminco, Belg. S. S.	Antwerp	Port Arthur	29 00 N.	91 40 W.	8	3a, 8	8	29.73	SSW	—	NW	W., 8	SSW.-WNW.
Bohemian Club, Am. S. S.	do	Baton Rouge	48 15 N.	10 15 W.	8	3p, 8	10	29.31	NNW	NNW., 8	W	W., 9	NW.-W.
Stuttgart, Ger. S. S.	Queenstown	New York	40 26 N.	28 23 W.	6	4a, 9	10	29.49	NNW	WNW., 5	W	NW., 10	Steady.
Lord Antrim, Br. S. S.	Rotterdam	Montreal	49 53 N.	59 24 W.	10	9p, 10	11	29.01	SSW	SW., 6	WSW	SW., 9	SSW.-SW.
New York City, Br. S. S.	New York	Cardiff	50 16 N.	20 25 W.	9	3a, 10	11	28.69	N	N., 10	NW	N., 10	Steady.
Providence, Fr. S. S.	Palermo	New York	41 15 N.	59 30 W.	11	Noon, 11	11	29.73	SW	SW., 6	WNW	NW., 9	—.
Yoro, Hond. S. S.	Kingston	do	28 48 N.	74 30 W.	12	7a, 12	12	30.14	NE	NE., 10	NE	NE., 10	Steady.
North Cornwall, Br. S. S.	Belfast	Philadelphia	54 00 N.	27 30 W.	12	Mdt., 12	14	28.48	WSW	W., 11	WNW	W., 11	W.-NW.
München, Ger. S. S.	New York	Cherbourg	51 01 N.	16 31 W.	11	Noon, 13	14	29.24	SW	W., 9	W	W., 11	SW.-W.
John D. Archbold, Am. S. S.	Baton Rouge	New York	35 46 N.	74 28 W.	15	Noon, 15	16	29.64	E	—	W	SE., 11	—.
E. J. Sadler, Am. S. S.	Baltimore	Baton Rouge	36 50 N.	75 50 W.	16	3a, 16	16	29.38	SE	SE., 10	SW	SE., 10	SE.-WSW.
Leviathan, Am. S. S.	New York	Cherbourg	48 57 N.	23 37 W.	16	4p, 16	18	—	WSW	WSW., 5	N	NNW., 11	NW.-NNW.
Trimountain, Am. S. S.	Canal Zone	London	28 28 N.	51 05 W.	15	6a, 17	17	29.86	NE	NE., 6	NE	NE., 8	Steady.
Endicott, Am. S. S.	Galveston	Havre	48 18 N.	26 45 W.	17	10a, 17	18	29.09	NW	NW., —	NNW	NW., 11	NW.-NNW.
Can. Highlander, Br. S. S.	Colon	Garston, Eng	49 21 N.	20 57 W.	17	10p, 17	18	28.72	WSW	WNW., 10	NNW	WNW., 11	WNW.-NNW.
Lucellum, Br. S. S.	Norfolk	Hull	47 45 N.	14 55 W.	17	3a, 18	19	28.52	WSW	WNW., —	NW	W., 11	NW.-N.-NW.
Collegian, Br. S. S.	New Orleans	Liverpool	51 40 N.	7 55 W.	17	3a, 18	18	28.76	S	S., 10	—	SSE., 11	Steady.
Shirak, Br. S. S.	Rotterdam	Beaumont, Tex.	43 40 N.	21 40 W.	18	3p, 19	20	29.45	NW	NW., 9	N	—, 11	Do.
Bellepline, Am. S. S.	do	New York	50 40 N.	0 30 E.	20	11a, 20	21	28.64	SE	SE., 8	WSW	WSW., 9	SE.-S.
Mijdrecht, Du. S. S.	Santander	do	43 18 N.	14 48 W.	17	11a, 20	22	29.13	SW	NW., 9	N	NNW., 10	SW.-N.-WSW.
Stadsdijk, Du. S. S.	Port Said	Boston	43 12 N.	44 50 W.	22	11p, 22	23	29.85	S	S., 7	NNW	S., 9	Steady.
Caucasier, Belg. S. S.	Antwerp	New York	49 45 N.	41 45 W.	21	6a, 23	24	29.20	S	W., 10	WNW	W., 10	W.-NW.
Frederik VIII, Dan. S. S.	Copenhagen	do	56 42 N.	27 50 W.	23	5a, 24	27	29.00	S	S., 7	WNW	W., 10	S.-W.
Albert Ballin, Ger. S. S.	Southampton.	do	45 05 N.	44 00 W.	25	10p, 25	26	29.79	SSE	W., 8	NW	NW., 10	SW.-W.
Manchuria, Am. S. S.	New York	Canal Zone	34 04 N.	75 20 W.	25	8p, 25	27	29.85	SSW	SSW., 7	WNW	W., 9	SSW.-W.
New York City, Br. S. S.	Bristol	New York	50 43 N.	20 45 W.	26	Mdt., 26	28	29.76	WNW	WNW., 8	NNW	WNW., 9	Steady.
San Benito, Br. S. S.	St. John, N. B.	Habana	42 20 N.	67 55 W.	26	7a, 27	28	29.34	SE	SW., 6	NW	W., 9	S.-WSW.
Asuncion de Larrinaga, Br. S. S.	Norfolk	Liverpool	39 04 N.	60 47 W.	26	10a, 28	30	29.80	S	SSW., 7	NE	S., 10	S.-NNW.-WSW.
Mijdrecht, Du. S. S.	Santander	New York	36 28 N.	52 45 W.	30	2p, 30	30	30.07	NNE	N., 9	N	N., 9	N.-NNE.
NORTH PACIFIC OCEAN													
El Oso, Br. S. S.	Nagasaki	San Francisco	44 00 N.	166 22 E.	Oct. 31	1a, 3	Nov. 5	29.22	WSW	NW., 10	NNW	NW., 10	WSW.-NNW.
Kongosan Maru, Jap. S. S.	Tama, Japan	Vancouver	41 45 N.	165 50 E.	Nov. 1	Noon, 3	4	29.53	WNW	W., 8	NW	W., 8	WSW.-WNW.
Bearport, Am. S. S.	Orient	Portland, Oreg.	41 50 N.	155 00 E.	4	5p, 4	5	29.78	SW	W., 9	W	W., 9	—.
D. G. Scofield, Am. S. S.	San Pedro	Balboa	15 17 N.	95 33 W.	5		5	29.92	NNE	—, 7	NNW	N., 8	NNE.-N.
Kaisho Maru, Jap. S. S.	Muroran	Victoria	45 13 N.	152 24 E.	6	10p, 6	7	29.16	WSW	WNW., 9	NW	WNW., 9	—.
Shabonee, Br. S. S.	China	San Pedro	40 36 N.	150 29 W.	6	10p, 6	7	29.52	SE	S., 7	WSW	SW., 9	—.
Handicap, Nor. S. S.	Shanghai	San Francisco	45 54 N.	170 33 E.	6	4a, 9	10	28.61	W	WSW., 10	N	W., 11	W.-NW.
El Oso, Br. S. S.	Nagasaki	do	47 20 N.	157 40 W.	7	2a, 9	10	28.58	SE	SW., —	W	SW., 9	SE.-SW.
Grace Dollar, Am. S. S.	Karatsu	do	47 35 N.	171 00 W.	9	Noon, 9	9	29.21	WNW	WNW., 9	W	WNW., 10	WNW.-W.
Iowan, Am. S. S.	Charleston	Los Angeles	14 37 N.	94 31 W.	9	11p, 9	10	29.86	NW	NW., 8	N	NW., 8	NW.-N.
W. S. Rheem, Am. S. S.	New York	San Pedro	13 11 N.	93 25 W.	11	7a, 11	11	29.83	N	N., 7	NE	N., 8	Steady.
Niagara, Br. S. S.	Honolulu	Victoria	47 00 N.	127 50 W.	11	6a, 11	11	28.93	SW	E., 7	SW	SW., 9	E.-S.-W.
Lurline, Am. S. S.	do	Seattle	38 55 N.	140 00 W.	11	6a, 11	12	29.60	W	W., 7	WNW	W., 9	Steady.
Blythmoor, Br. S. S.	Shanghai	Vancouver	49 28 N.	162 11 W.	11	1a, 11	13	29.26	NNW	NNW., 7	W	NW., 8	NNW.-W.
Oakridge, Am. S. S.	Portland	Yokohama	33 44 N.	142 00 E.	12	4a, 12	12	28.84	WNW	NW., 5	NE	NW., 8	WNW.-NW.
Somedono Maru, Jap. S. S.	Muroran	Willapa	51 44 N.	161 10 W.	13	6p, 14	14	29.83	SW	SW., 7	SSW	NW., 8	—.
Silveray, Br. S. S.	San Pedro	Yokohama	32 00 N.	166 00 E.	13	8p, 14	15	29.50	SE	NW., 5	W	SE., 9	Variable.
Taibu Maru, Jap. S. S.	Miike	Vancouver	49 25 N.	174 40 W.	13	1a, 16	17	29.20	S	S., 6	W	SSW., 9	36 pts.
Makiki, Am. S. S.	Seattle	Honolulu	37 05 N.	142 00 W.	14	2a, 14	16	29.70	N	N., 8	NW	N., 9	4 pts.
Makaweli, Am. S. S.	Puget Sound	Hilo	41 24 N.	135 24 W.	14	2p, 16	17	29.71	E	S., 7	SSW	SE., 10	SE.-S.
Harold Walker, Am. S. S.	Cristobal	San Pedro	14 52 N.	94 33 W.	15		15	29.85	N	N., —	NE	NE., 8	N.-NE.
Pres. Jackson, Am. S. S.	Seattle	Yokohama	46 25 N.	157 40 E.	15	2p, 15	16	28.80	SE	SW., 11	W	SW., 11	SE.-SW.-W.
H. T. Harper, Am. S. S.	Melbourne	San Pedro	25 50 N.	134 20 W.	15	2p, 15	16	29.94	ESE	ESE., 8	E	ESE., 8	—.
Sun, Am. S. S.	Balboa	do	13 58 N.	95 22 W.	18	8a, 18	18	29.92	NNW	NNW., 8	NE	NNW., 9	NNW.-NE.
Korea Maru, Jap. S. S.	Yokohama	San Francisco	43 00 N.	163 30 W.	18	4p, 20	20	29.43	SSE	SE., 8	SW	SE., 8	SE.-S.
Mongolia, Am. S. S.	San Pedro	New York	13 58 N.	94 25 W.	20	2p, 20	20	29.96	N	N., 4	N	N., 8	Steady.
West Sequana, Am. S. S.	Hongkong	San Francisco	35 30 N.	168 30 E.	19	5p, 21	22	29.43	SE	SW., 10	NW	SW., 10	SW.-W.
Egypt Maru, Jap. S. S.	Portland	Panama	43 10 N.	124 55 W.	20	2a, 21	21	29.93	E	S., —	S	S., 8	8 pts.
Niagara, Br. S. S.	Victoria	Honolulu	41 24 N.	137 37 W.	20	8a, 21	21	29.36	WNW	E., 4	NW	NW., 8	S.-E.-SW.
West Hixton, Am. S. S.	Osaka	San Pedro	45 37 N.	176 38 E.	21	—, 22	23	28.63	W	SE., 9	SW	SE., 9	SE.-SW.
Laurel, Am. S. S.	San Pedro	Balboa	15 02 N.	94 40 W.	22	6p, 22	23	29.95	NE	NE., 8	N	N., 9	NE.-N.
La Crescenta, Br. S. S.	Newchwang	San Pedro	32 43 N.	141 00 E.	23	2a, 24	24	29.50	NW	N., —	NE	NNE., 10	NW.-N.-NE.
Lurline, Am. S. S.	Seattle	Honolulu	41 30 N.	137 02 W.	23	6p, 23	26	29.26	SW	SW., 7	NW	W., 11	SW.-W.
Matsonia, Am. S. S.	San Francisco	do	35 17 N.	130 18 W.	25	11p, 25	27	29.68	W	W., 8	WNW	W., 9	W.-WNW.
West Hixton, Am. S. S.	Dairen	San Pedro	45 50 N.	159 00 W.	25	Noon, 28	28	29.00	SSE	SW., 7	W	SW., 9	SW.-W.
West Sequana, Am. S. S.	Hongkong	San Francisco	37 24 N.	163 25 W.	25	2p, 26	29	29.54	S	SSW., 6	W	WSW., 9	SW.-NW.
Akagisan Maru, Jap. S. S.	Yokohama	do	46 15 N.	171 30 E.	28	10p, 29	30	29.00	ESE	NNE., 9	NW	N., 10	ENE.-NNE.

NORTH PACIFIC OCEAN

By WILLIS E. HURD

Gales were more widespread over the North Pacific Ocean in November than in October, but, except in isolated localities, were not so severe. In October several gales of hurricane force resulted from typhoons near the Philippines and east of Japan; in November the highest reported wind force was 11, occurring in connection with extra-tropical cyclones, two west and one east of the one hundred and eightieth meridian. On the 9th and 10th the Norwegian steamer *Handicap* encountered one of these storm winds in the neighborhood of 46° N., 170° E. The American steamer *President Jackson* experienced the second on the 15th and 16th near 46° N., 158° E., in both cases pressure falling below 29 inches. On the 24th and 25th the American steamer *Lurline* fell in with similarly severe gales near 41° N., 137° W. In addition scattered gales of force 10 occurred on several dates. Storm conditions along the upper coast of the United States were, however, considerably severer than in October. Tatoosh Island, Wash., recorded a maximum velocity of 72 miles from the east on the 20th, beside other winds of 60 or more miles an hour on the 11th, 19th, 21st, and 29th.

No typhoons appear to have formed in the Far East, at least none of great extent. The American steamer *Stockton*, bound toward Manila, on the 4th experienced "a local disturbance reaching force 6–7 from south-southeast, with a heavy south-southeasterly swell running." This was in 19° 02′ N., 144° 25′ E., and was due to a depression central slightly to the westward on that date. This depression, slightly intensified, was central near 27° N., 140° E., on the following day, but thereafter was lost to observation.

Northers were frequent over the Gulf of Tehuantepec, though steamers reported none of force higher than 9. Gales of force 8 and 9 occurred here on the 5th, 6th, 9th, 10th, 15th, 18th, 20th, 22d, and 23d.

A storm of moderate intensity crossed central Japan on the 13th and 14th, and another disturbance, coming out of the Eastern Sea on the 21st, proceeded along the southern coast of Japan on the 22d, thence up the east coast on the 23d, whence it disappeared at sea. A storm of much greater intensity came out of Siberia on the 24th. It covered the Japan Sea on the 26th, crossed extreme northern Japan on the 27th, and was over the far western Aleutians at the close of the month.

As November opened the Aleutian LOW extended from central Alaska to the Hawaiian Islands, with the eastern North Pacific HIGH lying between the one hundred and fiftieth meridian of west longitude and the American coast from eastern Alaska southward. After the 10th of the month the LOW retreated northward, and by the 13th the HIGH dominated the eastern half of the ocean below the 45th parallel, except for a narrow trough of the LOW which was wedged southward along the one hundred and fiftieth meridian. On the 14th this southern extension was cut off from the main cyclone, then central over the eastern part of Bering Sea, and from it a new cyclone developed rapidly near 35° N., 142° W., giving moderate to whole gales over a narrow area midway between California and the Hawaiian Islands. An isolated portion of this new cyclone cut its way to the Washington coast, which it entered on the 15th, but the main storm area spread gradually from its center of the 14th, until by the 22d it covered the whole northern half of the ocean east of the one hundred and eightieth meridian, which great area it dominated until the end of the month, causing irregularly distributed gales throughout the period.

The following table gives an idea of the atmospheric pressure at selected land stations:

TABLE 1.—*Averages, departures, and extremes of atmospheric pressures at sea level at indicated hours, North Pacific Ocean, November, 1926*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Dutch Harbor [1] [2]	29.44	−0.15	30.26	19th	28.78	4th.
St. Paul [1]	29.54	−0.08	30.36	18th	28.74	2d.
Kodiak [1]	29.56	+0.02	30.40	19th	28.84	11th.
Midway Island [1]	30.02	−0.05	30.22	14th	29.74	25th.
Honolulu [3]	30.04	+0.02	30.12	22d	29.88	1st.
Juneau [3]	29.83	+0.07	30.45	18th	29.04	11th.
Tatoosh Island [3] [4]	29.86	−0.11	30.49	16th	29.17	24th.
San Francisco [3] [4]	30.04	−0.06	30.36	14th	29.60	26th.
San Diego [3] [4]	30.04	+0.04	30.22	15th	29.75	7th.

[1] P. m. observations only.
[2] 29 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.

At Honolulu the prevailing wind was from the northeast, with an average velocity of 8.1 miles per hour. During the daylight hours of the 14th, which was an exceptionally windy day, the average velocity was 27 miles an hour, with a maximum of 48 miles from the east. Only 0.12 inch of rain fell, which is 3.72 inches below the normal, and is the least of record for the month, and near the least for any month in 41 years.

Fog conditions did not differ materially from those of October, most frequent fog being observed along the American coast from a little north of San Francisco down to Cape San Lucas. Along the northern and central steamship routes it occurred on a few scattered days, but was especially widespread on the 15th and 16th.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The month as a whole may be classed as "cool and wet," with the reservation that parts of the area experienced the opposite conditions. It is noted that precipitation for the last several months has been above the normal over very considerable areas; the current month in the Pacific Coast States and the Plateau region gave abundant rains.

An unusual feature of the month was the occurrence of fully developed tornadoes as elsewhere mentioned. The usual details follow.—*A. J. H.*

CYCLONES AND ANTICYCLONES

By W. P. DAY

The low-pressure areas were mostly of the Pacific type, especially toward the end of the month, when the air pressure averaged above the normal at Fort Simpson in the Mackenzie Valley. And for a similar reason most of the migratory HIGHS were of the so-called Alberta type. There were 19 low-pressure areas, four of which developed considerable intensity over the Plains States and gave severe weather as they passed over the Lake region. The high-pressure areas numbered 14 and 9

of these might be classed as polar outbursts, while the remainder were mostly cold fronts which had traversed the Pacific. In spite of the rather marked outflow of polar air, the individual cold-air masses did not cause any unusual depressions of temperature.

FREE-AIR SUMMARY

By L. T. SAMUELS

Temperature departures for the month were negative at all stations and levels, the greatest departures occurring at Ellendale, the northermost station. (See Table 1.) The small average lapse rate for the month at this station is a characteristic feature of these higher latitudes during the cold season. It will be seen that the mean temperature was practically no lower at 2,000 meters than at the surface. This small lapse rate becomes even more pronounced and in fact changes to negative to an increasing altitude as the winter advances.

Close agreement is found in the monthly mean temperatures for Broken Arrow, Ellendale, and Groesbeck and the resultant winds at these respective stations. It will be seen in Table 2 that there occurred at the abovementioned stations either a greater northerly or smaller southerly component than normally. Rather marked exceptions in this respect occur, however, at Royal Center and Due West where despite a deficiency in the monthly mean temperatures the resultant winds contain a greater south component than normally. This anomaly was probably caused by the temperatures at the latter two stations being sufficiently low, on most of the days when the winds were northerly, to offset the relatively high temperatures occurring with southerly winds, even though the latter direction predominated in the resultants.

Relative humidity and vapor pressure departures indicated nothing unusual, the former being mostly positive and the latter negative. (See Table 1.)

Exceptionally strong winds prevailed at various elevations above the surface at a number of stations on the 25th, 26th, and 27th. During this period the center of an extensive low pressure area moved rapidly from Colorado to Quebec. On the morning of the first day Oklahoma City being ideally situated with respect to the LOW's center the pilot balloon observation showed the characteristic wind structure occurring in the southeast quadrant of a pronounced cyclone, viz, a rapid and marked increase in wind velocity off the surface to 600 meters (7 to 24 m. p. s.) followed by practically no change to 3,000 meters. The observation ended a few hundred meters higher and indicated a decrease in velocity in this upper stratum. The direction was south at the surface and veered to southwest at 600 meters where it remained to the highest altitude reached.

The far-reaching influence of this storm may be realized from the fact that on the 27th with its center over Quebec the wind at 5,000 meters above Atlanta, Ga., was 42 meters per second from the west-northwest and substantially the same at Due West, S. C., about 100 miles to the east. While such tremendous velocities prevailed at these elevations the winds in the lower layers were only light to moderate.

An unusually marked rise in temperature at an elevation of 2,500 meters, while during the same interval a much smaller increase occurred at the surface, is shown by the Broken Arrow kite records for November 21 and 22.

It will be seen from the above table that at the 2,500 meters level the temperature was 8.8° C. higher on the 22d than on the 21st. The increase in surface temperature during this time was only 4.5° C. On the morning of the 21st this station was in the southeast quadrant of a strong anticyclone whose major axis lay in a northwest-southeast direction and low temperatures and northerly winds prevailed. During the following 24 hours an unusually large and rapid movement of the upper (northern) portion of this HIGH took place, while the lower (southern) portion remained practically stationary, so that the major axis took an east-northeast west-southwest direction with Broken Arrow in the southwest quadrant. Warm southerly winds now raised the temperature in the upper strata to the extent shown above, while the effects of nocturnal radiation prevented such a large increase in the lower air until a considerably later hour in the day. It is of interest to note that exceptionally strong westerly winds prevailed from 1 to 3 kilometers over the northern Plains States, upper Mississippi and Ohio River Valleys coincidently with the rapid movement eastward of the northern portion of this anticyclone.

Altitude (m.) m. s. l.	21st (8 to 9 a. m.)		22d (7.30 to 10.30 a. m.)	
	Temperature	Wind direction	Temperature	Wind direction
	° C.		° C.	
233 (surface)	−3.5	N.	−4.8	SW.
500	−6.2	N.	−4.2	SSW.
1,000	−7.5	N.	−2.6	SW.
1,500	−4.5	NNE.	1.0	SW.
2,000	−1.6	NNE.	1.5	SW.
2,500	−3.1	NW.	5.7	W.
3,000	−4.1	WNW.	2.9	WNW.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during November, 1926*

Altitude, (m.)	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		Washington, D. C.[1] (7 meters)
	Mean	Departure from 9-year mean	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 9-year mean	Mean	Departure from 9-year mean	Mean
TEMPERATURE (° C.)											
Surface	6.8	−2.7	9.1	−1.6	−5.3	−3.1	11.6	−1.2	2.3	−2.1	4.3
250	6.7	−2.7	8.9	−1.0			11.3	−1.3	2.1	−2.1	3.5
500	5.3	−3.2	7.7	−1.8	−5.6	−3.4	10.6	−1.4	0.9	−1.9	3.1
750	4.3	−3.4	7.1	−1.5	−6.4	−4.3	10.0	−1.4	0.2	−1.8	2.4
1,000	4.0	−3.2	6.0	−1.7	−5.7	−3.8	9.4	−1.5	−0.3	−1.7	1.5
1,250	3.9	−2.8	5.4	−1.7	−5.0	−3.1	8.8	−1.4	−0.9	−1.7	0.6
1,500	3.8	−2.2	4.2	−2.1	−4.6	−2.5	7.9	−1.5	−1.4	−1.6	0.2
2,000	2.8	−1.4	2.3	−2.4	−5.4	−1.9	5.7	−1.8	−3.4	−1.8	−0.2
2,500	1.0	−1.0	0.9	−2.1	−6.8	−1.2	3.8	−1.7	−5.2	−1.8	−2.1
3,000	−1.4	−1.0	0.0	−0.8	−9.7	−1.5	2.2	−0.9	−7.8	−2.1	−4.6
3,500	−4.8	−1.9	−3.0	−1.1	−12.6	−1.6	−1.1	−1.4	−9.0	−1.3	−7.0
4,000	−8.1	−2.7			−15.9	−2.0	−3.4	−1.0	−11.8	−1.1	−10.4
4,500	−11.3	−3.3			−19.3	−2.5	−5.6	−0.3	−14.2	−0.8	
RELATIVE HUMIDITY (%)											
Surface	68	+2	70	+2	83	+4	68	−6	74	+1	81
250	68	+2	70	+3			66	−6	74	+1	79
500	66	+4	68	+5	83	+5	64	−3	72	0	74
750	64	+5	68	+7	81	+8	62	−1	71	+1	70
1,000	60	+4	70	+10	76	+8	60	+1	68	+2	69
1,250	54	+1	65	+8	72	+8	55	−1	64	+2	69
1,500	49	−1	61	+7	69	+8	52	−1	59	+1	67
2,000	41	−4	55	+8	66	+9	45	−3	56	+3	61
2,500	35	−7	43	+3	68	+11	37	−5	51	+2	59
3,000	38	−3	30	−8	69	+12	37	−2	52	+5	60
3,500	49	+10	30	−8	73	+15	37	−1	47	+2	61
4,000	61	+26			72	+11	36	+1	50	+6	63
4,500	61	+29			71	+9	37	+3	56	+12	
VAPOR PRESSURE (mb.)											
Surface	7.15	−0.79	8.79	−0.32	3.48	−0.83	9.78	−1.82	5.48	−0.85	6.91
250	7.08	−0.79	8.61	−0.33			9.41	−1.73	4.91	−1.35	6.44
500	6.39	−0.73	7.95	+0.04	3.38	−0.85	8.73	−1.28	4.36	−1.24	5.95
750	5.77	−0.72	7.79	−0.57	3.13	−0.80	8.11	−0.85	3.99	−1.10	5.39
1,000	5.10	−0.85	7.32	+0.67	3.06	−0.58	7.50	−0.58	3.60	−0.95	4.84
1,250	4.39	−1.00	6.35	+0.41	3.00	−0.39	6.54	−0.65	3.21	−0.82	4.44
1,500	3.71	−1.11	5.40	+0.17	2.95	−0.21	5.62	−0.77	2.79	−0.70	4.00
2,000	2.86	−0.96	4.06	+0.17	2.58	−0.10	3.92	−0.97	2.26	−0.62	3.44
2,500	2.30	−0.72	2.71	−0.15	2.34	+0.06	2.97	−0.70	1.77	−0.51	2.83
3,000	2.02	−0.44	1.70	−0.54	1.86	−0.02	2.81	+0.10	1.39	−0.58	2.35
3,500	2.04	+0.18	1.18	−0.63	1.56	+0.01	2.59	+0.48	1.04	−0.57	1.99
4,000	1.98	+0.69			1.19	−0.10	2.45	+0.94	0.73	−0.35	1.55
4,500	1.90	+0.98			0.85	−0.27	2.37	+1.32	0.65	−0.12	

[1] Naval air station.

TABLE 2.—*Free-air resultant winds (m. p. s.) during November, 1926*

Altitude, (m.)	Broken Arrow, Okla. (233 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)				Washington, D. C. (34 meters)	
	Mean		9-year mean		Mean		6-year mean		Mean		9-year mean		Mean		9-year mean		Mean		9-year mean		Mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 43° W.	1.6	S. 42° W.	1.5	S. 42° W.	1.2	N. 81° W.	0.6	N. 17° W.	3.0	N. 50° W.	2.3	S. 62° W.	1.2	N. 72° E.	0.1	S. 37° W.	3.1	S. 47° W.	2.2	N. 61° W.	1.8
250	S. 41° W.	1.7	S. 40° W.	1.6	S. 40° W.	1.2	N. 83° W.	0.7					S. 24° W.	2.4	N. 46° W.	0.6	S. 36° W.	3.6	S. 51° W.	2.8	N. 72° W.	3.2
500	S. 80° W.	1.6	S. 40° W.	2.3	S. 49° W.	1.9	S. 88° W.	1.3	N. 25° W.	2.8	N. 59° W.	2.6	S. 33° W.	4.5	S. 4° E.	1.6	S. 37° W.	6.6	S. 56° W.	5.4	N. 73° W.	4.9
750	S. 49° W.	2.9	S. 42° W.	3.3	S. 51° W.	2.7	W.	1.9	N. 32° W.	4.0	N. 60° W.	4.1	S. 32° W.	5.5	S. 24° W.	2.2	S. 43° W.	8.0	S. 61° W.	6.7	N. 74° W.	5.9
1,000	S. 70° W.	4.3	S. 55° W.	4.0	S. 55° W.	4.0	S. 85° W.	2.7	N. 37° W.	4.6	N. 64° W.	4.9	S. 53° W.	5.7	S. 44° W.	2.9	S. 54° W.	8.6	S. 69° W.	7.3	N. 75° W.	6.8
1,250	S. 80° W.	5.8	S. 64° W.	4.8	S. 70° W.	6.1	W.	4.1	N. 40° W.	5.4	N. 65° W.	5.9	S. 61° W.	5.8	S. 57° W.	3.5	S. 61° W.	7.8	S. 72° W.	7.5		
1,500	N. 85° W.	6.9	S. 72° W.	5.5	S. 67° W.	7.0	S. 88° W.	5.4	N. 40° W.	6.8	N. 62° W.	7.0	S. 76° W.	6.4	S. 69° W.	4.1	S. 67° W.	9.0	S. 77° W.	8.7	N. 79° W.	8.5
2,000	N. 75° W.	8.1	S. 79° W.	6.9	S. 71° W.	8.5	S. 86° W.	7.5	N. 41° W.	8.2	N. 64° W.	8.7	S. 89° W.	7.0	S. 81° W.	5.4	S. 81° W.	10.1	S. 83° W.	10.0	N. 84° W.	10.7
2,500	N. 67° W.	9.5	S. 85° W.	7.6	S. 84° W.	10.7	S. 87° W.	9.1	N. 38° W.	11.1	N. 64° W.	10.9	S. 83° W.	10.0	S. 84° W.	7.2	S. 80° W.	11.6	S. 84° W.	11.7	S. 83° W.	11.4
3,000	N. 64° W.	12.0	S. 86° W.	8.7	S. 86° W.	14.5	S. 84° W.	10.5	N. 49° W.	13.6	N. 67° W.	12.8	N. 68° W.	13.0	S. 87° W.	8.8	N. 85° W.	12.6	N. 88° W.	13.0	S. 83° W.	15.1
3,500	N. 60° W.	14.4	S. 87° W.	9.4	W.	14.5	S. 85° W.	11.8	N. 63° W.	16.2	N. 66° W.	13.9	S. 68° W.	16.1	S. 75° W.	10.5	S. 87° W.	15.1	N. 85° W.	13.4	S. 78° W.	15.6
4,000	W.	12.0	S. 84° W.	10.6					N. 62° W.	15.1	N. 66° W.	13.5	W.	16.0	S. 72° W.	8.6	N. 71° W.	15.9	N. 87° W.	13.0	S. 90° W.	17.6
4,500	W.	13.9	N. 84° W.	10.6					N. 74° W.	20.6	N. 62° W.	15.8	W.	17.0	S. 60° W.	10.7	W.	12.0	S. 84° W.	13.0	N. 83° W.	18.4
5,000	S. 68° W.	16.0	S. 73° W.	11.9													W.	11.0	W.	15.5	N. 88° W.	21.8

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

The first week was moderately free from important cyclonic or anticyclonic movements in any part of the country, and this condition continued in the more western districts until the close of the first decade.

By the morning of the 8th, however, a cyclone of slight intensity, that had moved from the far Northwest, reached central Oklahoma and had developed into a well-defined storm. This moved to the Great Lakes and lower St. Lawrence Valley during the following 48 hours, attended by widespread precipitation from the Mississippi Valley eastward, with heavy rains in the Gulf States, Ohio Valley, and North Atlantic States and more or less snow or sleet in the lake region and to eastward.

In connection with this cyclone numerous thunderstorms occurred on the afternoon of the 9th over the southeastern and eastern States, and a small, but severe, tornado occurred at La Plata, Md., causing the death of 17 persons, mostly children, when a schoolhouse was blown to pieces, injuring a number of others, and destroying a number of houses and other property. (See p. 462, this REVIEW.)

At the beginning of the second decade low pressure developed over the North Pacific coast attended by precipitation, which gradually extended over all parts of the coast, and became heavy in northern California and over the coast districts of Oregon and Washington.

With a short return to anticyclonic conditions over this area about the middle of the month, rainy conditions again overspread the far Northwest and continued without material breaks till the end of the month, the precipitation area extending frequently to all parts of the coast States, with local heavy rains at the lower elevations and some heavy snows in the mountains.

In the districts from the Rocky Mountains eastward, an important cyclone moved from the middle Plains to the upper Lakes on the 13th to 15th, and with secondary formations the precipitation area was extended to nearly all eastern districts during the following two days. Heavy rains occurred in connection with this cyclone over the upper Mississippi Valley, portions of the Gulf States, Ohio Valley, and to the northeastward.

Immediately following the storm referred to above, another, having its origin in the far Northwest, crossed the Rocky Mountains about the 16th and moved southeastward to central Texas, and thence to central Arkansas during the following 24 hours, but without material precipitation. From Arkansas the storm moved northward to the Great Lakes during the following 48 hours, and, as in that just preceding, a secondary LOW developing to the eastward caused precipitation, mostly light, over practically all central and eastern districts, light snows occurring over the more northern sections.

The latter half of the month was mainly free from cyclonic disturbances from the Rocky Mountains eastward until the 25th, when a cyclone of wide extent, an offshoot from the general low-pressure area in the extreme Northwest, was central over eastern Colorado, and moved rapidly to the Great Lakes and lower St. Lawrence Valley during the 26th and 27th. This storm was attended by thunderstorms over wide areas on these dates, and several distinct tornadoes occurred during the late evening of Thanksgiving day in the lower Mississippi Valley, notably in Arkansas, Louisiana, Mississippi, and Missouri, when a considerable number of lives were lost and much damage to property occurred. A more complete history of these tornadoes appears on p. 466 in this issue. Moderate precipitation from this storm occurred from the Mississippi River eastward, some sleet and glaze in the upper Lake region and more or less snow in all northern districts from the Dakotas eastward.

The last day of the month brought considerable precipitation over the Atlantic coast and middle Gulf States and about the same time over the Pacific coast from north-central California to Washington heavy precipitation occurred. A fall of over 5 inches at Eureka, Calif., on the 29th and 30th established a new record of heavy rainfall for November at that place.

Anticyclones were mainly of only moderate intensity, though that moving southward from Manitoba about the 9th and drifting slowly southeastward during the following few days, caused sharp falls in temperature as it advanced eastward and dominated the weather over the eastern half of the country for several days.

A moderate anticyclone, moving along the northern border from the 26th to 28th, was attended by sharp falls in temperature as it advanced eastward and by the coldest weather of the month over the northern districts from Minnesota to New England.

The average pressure reduced to sea level was highest over the Southeastern States, where it was slightly above normal, and lowest in the far Northwest where it was materially lower than normal. In general, pressure was above normal over the Atlantic and Gulf States, in the far Southwest, and over the upper Missouri Valley and adjacent Provinces of Canada, and below in other areas.

Compared with October, the average pressure was lower only in the far Northwest, otherwise it was higher in all parts of both the United States and Canada, a condition not unusual though the increases over October were materially greater than usual.

Important wind storms were confined mainly to the Lake region and eastern coast districts, to the North Pacific coast States during the latter half of the month, and to the lower Mississippi Valley and near-by areas on the 25th where several tornadoes of considerable importance occurred. The details concerning these will be found in the table on severe local storms at the end of this section.

TEMPERATURE

Important temperature changes were confined mainly to a few dates, notably the 9th and 10th over the districts from the Mississippi River eastward, 20° to 30° colder, and during the 26th to 29th, when sharp rises and falls ranging from 20° to 40° in 24 hours occurred in quick succession over the districts from the Rocky Mountains eastward.

The first week was decidedly cold in the central Gulf districts and near normal in other portions of the country east of the Rocky Mountains. To the westward the week was mainly warmer than normal. The week ending the 16th was generally colder than normal over the central valleys and Southern and Southeastern States, decidedly so in the lower Mississippi Valley and middle Gulf States where the negative departures ranged from 6° to 9°. Over most western districts and in the Northeastern States this week was mainly warmer than normal. The third week was decidedly cold over the greater part of the country, particularly from Montana and the Dakotas southeastward to the Carolinas and Georgia where the weekly averages ranged from 9° to 15° below the normal. Over a small area in the Northeast and in most districts west of the Rocky Mountains, save Wyoming, Montana, Idaho, and eastern Washington, the averages were above normal, materially so in the middle Plateau and near-by areas. The last week was mainly decidedly warmer than normal in all districts save from Montana eastward to the upper Lakes, where it continued cold as during the preceding week.

The month as a whole was warmer than normal from the Rocky Mountains westward, and over the Northeastern States and in the adjacent Canadian Provinces. In the far West it was a decidedly warm month, in some cases as warm as any previous November. In portions of the Northeastern States it was the first month since January with temperature averages above normal.

Over the interior valleys, South Atlantic and Gulf States the month was decidedly cold, the averages ranging up to 5° or more per day below normal. In the Gulf States the month was cold nearly throughout, only a few days during the latter part having temperatures appreciably above the normal.

The warmest periods were usually during the first week from the upper Lakes westward and southwestward to the Pacific coast and in portions of the Gulf States. Elsewhere they occurred on widely scattered dates.

The coldest periods were rather widely scattered, but mostly during the latter half, about the 15th to 22d over much of the territory west of the Mississippi River and in portions of the Ohio Valley and some Gulf and Eastern States, and from the 26th to 28th at points along the northern border from North Dakota eastward.

PRECIPITATION

Considering the precipitation by States nearly all had averages in excess of the normal, only eight showing averages below normal. In general, the excesses were fairly large as compared with the normal and the deficiencies were mainly comparatively small, so that for the country as a whole the precipitation was generous and well above normal, only small areas going into the winter with depleted water supplies.

Over the Pacific Coast States the precipitation was mainly heavy to excessive, particularly in California, where the average for the State as a whole exceeded the normal by more than 5 inches, and it was the wettest November of record since state-wide observations of precipitation began.

The only extensive areas with precipitation below normal were the States from Arizona eastward to Texas and Arkansas, and in the immediate Ohio Valley. In all other sections only small areas had less than the normal precipitation.

SNOWFALL

Snow was rather widely distributed, but usually the amounts were not large and did not remain long on the ground, save in the higher mountain districts.

Unusually heavy snow for November occurred in central Illinois and near-by areas on the 17th and 18th, and locally in the lower Ohio Valley on the 20th and 21st.

Over the northern border States snowfall ranged up to 5 or 10 inches in New England and New York, from 15 to 30 inches in the upper Lake region, and from 5 to 10 inches from Illinois and Wisconsin westward to the foothills of Wyoming and Montana. In the Rocky Mountains the depths ranged from 10 inches or more in northern New Mexico, to 30 or 40 inches at high elevations in Colorado and Wyoming. In the northern Rocky Mountains the amounts were generally less, and in the Plateau the depths depended on elevation, very little falling at the lower levels. In the Cascades of Oregon and Washington there were some heavy falls, Crater Lake, Oreg., having a total of about 10 feet. In the Sierra Nevada there were local heavy falls on some of the highest mountains, but at the moderate elevations there was little snow at any time during the month.

RELATIVE HUMIDITY

The percentages of relative humidity, like the totals of precipitation, were mainly above the normal, except in the Southwest, in portions of the Ohio Valley and over much of the Gulf coast region. In portions of southern California the relative humidity was much below normal, despite the excess of precipitation, and similar conditions existed in some southeastern States.

The changes from normal save as indicated above were mainly small.

SEVERE LOCAL HAIL AND WIND STORMS, NOVEMBER, 1926

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Groesbeck, Tex	7	10 p. m.	60		$10,000	Tornadic wind and hail.	Shade trees uprooted and weak buildings demolished at points along path 2 miles long. Heavy hail broke many windows. One person injured.	Official, U. S. Weather Bureau.
La Plata (near) to Cedarville, Md.	9	2.30 – 3.15 p. m.	33–167	17	100,000	Tornado	Five dwellings and a schoolhouse wrecked, 4 homes damaged, 14 barns and contents a total loss, and 14 school children and 3 adults killed at La Platta. A number of buildings damaged or wrecked in Cedarville. Small buildings, fences, and poles leveled over a path 18 miles long.	Do. Post (Washington, D. C.)
Alpena, Mich	9–10					Wind and snow	Drifted snow caused tie-up of traffic; streets and highways impassable in places.	Official, U. S. Weather Bureau.
Atlantic City, N. J. (off coast of).	15–16					High wind	Tug boat with oil tanker in tow stranded; oil salvaged but tug almost total wreck.	Do.
Allentown, Pa	16	A. m.				High wind and rain.	Several houses unroofed and wires and poles blown down.	Do.
Chester County, Pa	16	do				Gale	Waterfronts badly damaged; part of sea wall washed away; poles and trees blown down.	Do.
Philadelphia, Pa	16	do				Wind and rain	Some damage at Exposition grounds by rain; minor damage by falling signs, etc.	Do.
Reading, Pa., and vicinity	16	do				do	Several roofs blown off; trees uprooted; windows broken.	Do.
Trenton, N. J., and vicinity	16	do				do	Homes damaged; telephone and telegraph poles prostrated; trees broken; 3 persons hurt.	Do.
Connecticut and Massachusetts.	16			4		High winds and rain.	Storm left trail of damaged buildings, trees, and tangled wires in its wake. Many persons injured; U. S. Cutter *Morrill* wrecked and a score of fishing boats sunk. Traffic and telephone service demoralized.	Courant (Hartford, Conn.). Post (Boston, Mass.).
Southern and Central, Wis.	17–18					Wind and snow	Damage principally to overhead wire systems	Green Bay Press Gazette (Wis.).
Eastern Iowa	18					do	Highways blocked; much corn blown down	Official, U. S. Weather Bureau.
Scotia, Calif	23	11 a. m.				Wind	Windows broken, some damage to roofs. One person slightly injured.	Do.
Clovis, N. Mex., and vicinity.	25					High wind	Barns and windmills demolished and stacked grain ruined. Small buildings wrecked in city.	The New Mexican (Santa Fe.).
Southwestern Oklahoma	25				36,000	do	Mill building wrecked injuring 4 men	Fort Smith Journal (Ark.).
San Francisco, Calif	25					Rain and wind	Damage principally by flooding; traffic interrupted; shipping delayed. A few trees blown down.	Official, U. S. Weather Bureau.
Northwestern Texas	25			1		Severe sandstorms.	Much cotton ruined; windmills, telephone lines, signs and buildings of weak contruction damaged.	Do.
Barry to Henry County, Mo., into Illinois.	25	4–5 p. m.				Thunderstorm, wind and hail.	Character of damage not reported	Do.
Laclede to Phelps Counties, Mo.	25	5–6.30 p. m.	100–880	2	30,400	Tornado	Homes, barns, trees and crops damaged or destroyed; livestock killed; 11 persons injured.	Do.
Howell and Oregon Counties, Mo.	25	6.20 p. m.	440–800	4	119,500	do	Heavy damage to all kinds of buildings; 40 or more persons injured.	Do.
Pope to Van Buren County, Ark.	25	P. m.		8		do	Property damage especially heavy around Choctaw and Culpepper.	Times Record (Fort Smith, Ark.).
Perry and Conway Counties, Ark.	25	6.30 p. m.		5		do	A number of homes and barns demolished or damaged.	Southwest American (Fort Smith, Ark.).
Faulkner and Cleburne Counties, Ark.	25	P. m.		22	500,000	do	Property damage severe, north section of Heber Springs almost totally wrecked. Roads impassable; many persons injured.	Do.
Newport, Ark. (near)	25	do		2		do	Several houses blown down	Times Record (Fort Smith, Ark.).
Sheridan, Ark	25	do		1		do	Character of damage not reported	Southwest American (Fort Smith, Ark.
Moscow, Ark., and vicinity.	25	do	200	10		do	Heaviest property damage at Moscow; about 40 persons injured.	Times Record (Ft. Smith, Ark.).
Macedonia, Ark	25	do		2		do	One home completely destroyed; other minor damage.	Do.
Claiborne Parish, La	25	8.45 p. m.	33–100	7	100,000	do	Buildings, timber and crops wrecked or badly damaged; livestock killed. Seventeen persons injured. Path 14 miles long.	Official, U. S. Weather Bureau.
Morehouse Parish, La	25	11.30 p. m.	100	11	11,475	do	Small buildings practically destroyed; cotton and corn damaged; some livestock killed. Thirty-eight persons injured. Path 4 miles long.	Do.
Marks (near), Miss	25	P. m.		10		Violent wind	Unsubstantial buildings damaged and a number of negroes injured.	Do.
Tennessee	25–26					High winds	Minor damage at many points throughout State.	Do.
Florence, Tenn	26	A. m.	200		2,000	Tornado	Railway station and church practically demolished and a number of trees blown down. Path several miles long.	Do.
Winfield, Ala. (1 mile north of).	26	5.30 a. m.	150	4	25,000	do	About 20 buildings destroyed or badly damaged over path 7 miles long. Five persons slightly injured.	Do.
South Carolina (northern tier of counties).	26	4–5 p. m.	250	1	366,000	Series of severe thunderstorms and wind.	Church blown down and many other buildings damaged; trees prostrated; telephone service impaired; 12 persons injured.	Do. Greenville News (Greenville, S. C.).
Graham, N. C. (8 miles southwest of).	26	6.30 p. m.	100		25,000	Tornado	Several frame buildings destroyed; many trees uprooted or twisted off; path 2 miles.	Official, U. S. Weather Bureau.
Eastern Lake Superior	26	P. m.				Gale	Several freighters swept ashore; one lumber steamer a total wreck, others damaged.	Courier Express (Buffalo, N. Y.).
Conover (near), Tryon, Statesville, Salisbury and Winston-Salem, N. C.	26					Heavy hail	Hail over small areas did considerable damage to windows and automobiles.	Official, U. S. Weather Bureau.
Portsmouth, Va., and vicinity.	26			2	150,000	Severe thunderstorm and wind.	Warehouses and contents badly damaged; minor injury to trees, dwellings, and other small buildings.	Do.
Houghton, Mich., and vicinity.	30					Wind and snow	Two vessels wrecked on Keweenaw Point	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

Storm warnings were issued during the month in advance of four storms. They were southeast warnings in each instance and all were for the Atlantic coast from Cape Hatteras northward.

The first disturbance of marked intensity that crossed the Washington Forecast District was central over northern Indiana the morning of the 9th, and storm warnings were displayed at 10 a. m. from Delaware Breakwater to Eastport, Me. Practically every station reported a verifying velocity, the highest being 48 miles an hour from the southwest at Nantucket, Mass.

During the 15th warnings were ordered displayed from Cape Hatteras to Eastport in connection with a storm of marked intensity then moving northeastward over the upper Lake region. A secondary disturbance developed over the southern Appalachian region the afternoon of the 15th and moved rapidly northeastward. As a result, gales were experienced generally along the coast from Wilmington, N. C., to Eastport. The wind attained a velocity of 72 miles an hour from the southeast at both New York City and Atlantic City.

The next warnings were displayed on the 18th and 19th from Delaware Breakwater to Boston and from Rockland, Me., to Eastport. Winds of gale force were reported only from Atlantic City and Eastport, inasmuch as the secondary disturbance for which they were issued did not increase materially in intensity as it advanced northeastward from western North Carolina.

The last warnings of the month were issued at noon of the 26th from Cape Hatteras to Eastport in advance of a storm of marked intensity and wide extent then central over lower Michigan. Nearly all stations reported winds of gale force, New York City and Block Island reporting 60 miles an hour from the northwest.

Small craft warnings were ordered on the 17th from Bay St. Louis, Miss., to Apalachicola, Fla., and warnings of strong northerly winds for the Canal Zone were issued on the 10th, 11th, and 16th.

Advisory warnings were issued from the 14th to the 16th, inclusive, in connection with a tropical disturbance of minor intensity that developed about 200 miles north of Colon, Canal Zone. This disturbance moved northwestward past Swan Island and later recurved toward the northeast. It passed over western Cuba the night of the 15th–16th and merged the following day with a trough of low pressure that extended southward from a disturbance of wide extent over the eastern half of the United States.

Cold wave warnings.—The following warnings were issued: 9th, for western Kentucky, northwestern Tennessee, and northwestern Ohio; 10th, for the northern portions of eastern New York and for northern New England; 26th, for the lower Lake region and the Ohio Valley; 27th for New England and the northern portion of eastern New York; 30th, for northern Ohio. These warnings were fairly well verified.

Frost warnings.—Frost warnings were issued on 12 days during the month. Those issued on the 1st and 2d were for northern sections, and by the 3d killing frost had occurred almost generally except in the south Atlantic and east Gulf States. After the middle of the month the warnings were confined to the extreme South.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

Storm warnings.—November, 1926, was an unusually stormy month on the Great Lakes. In fact, there were but few days without either strong winds or gales on at least some portion of the Lakes. At Buffalo, N. Y., on Lake Erie, gales occurred on one-half the days of the month. Storm warnings of some character had to be issued on 19 days, and small-craft warnings were called for on 5 additional days. Eleven disturbances crossed the Lakes, and of these the storms of the 8th–10th, 17th–20th, and 25th–27th were the most severe. In each of these three cases the barometric depression first moved from the far Northwest well to the southeastward across the Rocky Mountains to the southern or central Great Plains region and thence recurved and advanced northeastward toward the Great Lakes with increasing intensity. In the case of the storm of the 17th–20th, however, its force began to lessen about the time the center reached the Great Lakes, but winds of storm intensity had occurred over the upper lakes immediately preceding the arrival of the center there. Another fact of interest in connection with this disturbance is that it is difficult to trace its point of origin farther westward than the coast of Washington. Possibly this is owing to the absence of vessel reports from the Pacific Ocean for Sunday, the 14th.

The highest wind velocity reported from any Great Lakes station during the month was at the rate of 72 miles an hour from the southwest, at Buffalo, N. Y., on the 9th.

In the great majority of cases the storm warnings were timely, but in a few cases winds of storm force occurred over limited districts without warnings. The most notable case of this kind was at Sault Ste. Marie, on Lake Superior, where for three hours on the early morning of the 24th the wind velocity equaled or exceeded the verifying velocity. In this connection, however, an advisory message had been sent to that station on the night of the 23d to the effect that a disturbance of increasing force was centered that night over northern Lake Superior and that it would cause rather strong winds on the lake during the following 12 to 24 hours.

Frost warnings.—Frost warnings were still needed in portions of the extreme southeastern part of the district at the beginning of the month. The final warning of this character for the season was issued for extreme southern Illinois on the 4th.

Cold wave warnings.—These were issued on six dates, namely, the 9th, 17th, 18th, 25th, 26th, and 30th. Those on the first three dates were for areas in the extreme eastern part of the district, while the warnings on the last three dates covered larger geographic areas. This was especially true as to the warnings on the 30th, which included in their scope much of the northern and central portions of the district. Generally speaking, the cold wave warnings were well verified.

Stock warnings.—These were issued on only one occasion, namely, on the 25th, for South Dakota, Nebraska, and Kansas.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

Warnings for frosts or freezing were issued for the northern portion of the district on several dates, and southward into the sugar and trucking region on the 9th, 10th. 15th, 17th, and 18th. Subsequent conditions justified the warnings.

Northwest storm warnings were displayed on parts of the Texas coast on the 17th and 21st, and small craft warnings were displayed on the 4th, 7th, 8th, 16th, 17th, 21st, and 25th. No general storm occurred on the West Gulf Coast without warning.

Cold wave warnings were issued for Oklahoma and Arkansas on the 8th; for Arkansas and the interior of eastern Texas on the 19th; and for Oklahoma and the Texas Panhandle on the 25th. The temperature fell sharply in each case but the required minimum temperature did not occur. No cold wave occurred without warning.

Fire weather warnings were issued for parts of the district on the 8th, 17th, 25th, and 27th.—*I. M. Cline.*

DENVER FORECAST DISTRICT

Frequent LOWS of marked intensity which advanced from the north Pacific coast southeastward across Wyoming were attended by precipitation, generally light, in the northern portion of the district during most of the month, while mostly fair weather prevailed in the southern portion. Temperatures were generally above normal in about all sections during the first half of the month and were much lower than the seasonal average on the northeastern Rocky Mountain slope after the 16th.

Warning of a cold wave which was fully verified, was issued for southeastern Wyoming and extreme north-central Colorado on the morning of the 20th. A cold wave warning issued on the morning of the 25th for eastern and central Colorado and southern and western Wyoming was verified in extreme eastern Colorado. Although a sharp fall in temperature occurred in central Colorado and southern Wyoming, the minimum temperature required for a full verification was not reached in these sections, owing to the unusually rapid extension southeastward of a storm that remained central off the Washington coast. Warnings were also issued on the morning of the 30th of a severe cold wave in southern Montana and of a moderate cold wave in northeastern Wyoming. The warning was fully verified in southeastern Montana, but was only partially verified in northeastern Wyoming, owing to the very rapid movement eastward of a HIGH that was approaching over Saskatchewan.

On account of the abnormal rise in temperature at Denver during the night of the 15th–16th which reached its maximum at about 2 a. m. of the 16th, a cold wave, without warning, as shown by the thermograph trace, occurred during the 24 hours ended at 2 a. m. of the 17th. Other local cold waves without warning occurred as follows: Flagstaff, 3d and 28th; Durango, 8th; Leadville, 17th; Helena and Yellowstone Park, 19th; Miles City, 20th.

Freezing temperature warnings were issued on the 8th for extreme eastern New Mexico. Frost warnings were issued as follows: 4th, extreme southeastern New Mexico; 9th, southern New Mexico, freezing in extreme southeast portion; 15th, 17th, and 25th, south-central and southeast Arizona. Warnings of this class were generally verified.

Special forecasts of strong winds, principally for the benefit of aviation interests in southern Wyoming and eastern Colorado were issued on the 6th, 10th, 11th, 12th, 15th, 16th, 17th, 18th, 22d, 23d, 24th, 25th, 26th, 27th, and 29th. These were also generally verified.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

Beginning on the 13th of the month a radical change from the normal pressure distribution set in over the north Pacific Ocean. The first sign of this change was the appearance on the 13th of a slight fall in pressure northeast of the Hawaiian Islands. Subsequently this became general and a system of low pressure of great area formed and dominated the wind, weather and temperature conditions generally over the northeast Pacific Ocean and over this forecast district from the middle to the end of the month. This system of low pressure required the period from the 13th to the 28th, inclusive, to move from the vicinity of the Hawaiian Islands to the western coast of North America, and while it was doing so a number of secondary cyclonic systems formed, moved eastward, and gave gales and rains over the far western States. At the close of the month, pressure remained low over the ocean generally this side of the one hundred and eightieth meridian and north of the thirtieth parallel of latitude. In consequence, rains were frequent in the far western States during the latter half of November, and were heavy over most of California. Temperatures were mild generally, although for a brief period during the middle of the month low temperatures prevailed over the interior of Washington and Oregon and over Idaho and Nevada. No frost warnings were required for southern California and only one was issued for northern California, where light frost in exposed places was forecast on the 14th.

Storm warnings were issued on the 8th, 10th, and 11th for the north coast and from the 20th on to the 29th storm warnings were ordered for some part of the coast on nearly every day. Gales were frequent and severe, but there is no record of loss of vessels, probably because of the timeliness of the storm warnings.—*E. H. Bowie.*

RIVERS AND FLOODS

By R. E. Spencer

Heavy rain over the middle and north Atlantic States on the 15th and 16th caused moderate overflows in the Saluda, James, Unadilla, Lehigh, and Susquehanna Rivers following the 16th. Of these the flood in the Susquehanna was the most extensive, but neither it nor the others did great damage. Crops had been harvested; warnings were in general ample and accurate; and losses were confined to unavoidable damage to highways and bridges—$75,000 loss reported from the Susquehanna drainage area; and $100 from the James, with $1,500 given as the value of property saved by Weather Bureau warnings.

Of the rises in the various tributary streams of the Ohio System which resulted from the heavy general rain of the 15th–16th over that section, the only specific report of damage covered that section of the Little Kanawha drainage area in the vicinity of Glenville, W. Va., and placed the amount of damage to merchandise, household goods, and other commodities at $30,000, in addition to a $30,000 loss in corn and hay. Interrupted wire communication rendered impossible the issue of timely warnings to Glenville, where the highest water of record occurred on November 16, but for the other streams in the Ohio drainage warnings were ample and damage unimportant.

The Illinois River, which fell below flood stage at several points before the middle of November, rose again and was above the flood stage at all stations except Morris, Ill., at the end. No additional damage has been reported.

The floods in the lower Rio Grande and the upper Willamette were well forecast and without serious consequence.

River and station	Flood stage	Above flood stages—dates From—	Above flood stages—dates To—	Crest Stage	Crest Date
ATLANTIC DRAINAGE	Feet			Feet	
Lehigh, Mauch Chunk, Pa	12	17	17	13.5	17
Susquehanna:					
Oneonta, N. Y	12	17	17	12.3	17
Bainbridge, N. Y	11	18	21	11.5	19
Binghamton, N. Y	14	17	17	14.4	17
Towanda, Pa	16	17	17	16.6	17
Wilkes-Barre, Pa	20	17	18	22.8	17
Harrisburg, Pa	17	17	17	17.0	17
Unadilla, New Berlin, N. Y	8	17	19	9.0	17
James, Columbia, Va	18	18	18	19.6	18
Saluda, Pelzer, S. C	7	16	16	7.0	16
MISSISSIPPI DRAINAGE					
Tuscarawas, Gnadenhutten, Ohio	9	1	3	11.4	1
Little Kanawha:					
Glenville, W. Va	23	16	17	33.6	16
Creston, W. Va	20	17	17	23.7	17
Scioto, Circleville, Ohio	10	(1)	2	11.5	1
Tippecanoe, Norway, Ind	6	16	16	6.2	16
French Broad, Asheville, N. C	4	16	16	4.0	16
Big Pigeon, Newport, Tenn	6	16	16	6.4	16
Illinois:					
Morris, Ill	13	15	20	14.9	16
Peru, Ill	14	(1)	7	23.4	Oct. 7.
		14	(2)	19.9	Nov. 19.
Henry, Ill	10	(1)	1	18.2	Oct. 8-9.
		15	(2)	14.5	Nov. 22.
Peoria, Ill	18	17	(2)	21.0	Nov. 23-24.
Havana, Ill	14	(1)	11	23.47	Oct. 12.
		14	(2)	18.6	Nov. 29-30.
Beardstown, Ill	14	(1)	(2)	26.25	Oct. 12.
Second rise				20.4	Nov. 29-30.
Pearl, Ill	12	(1)	12	22.0	Oct. 6-7.
		14	(2)	16.4	Nov. 30.
Petit Jean, Danville, Ark	20	16	18	21.9	Nov. 17
WEST GULF DRAINAGE					
Guadalupe, Victoria, Tex	16	1	1	17.8	1
Rio Grande:					
Rio Grande City, Tex	21	1	1	[3] 21.5	1
San Benito, Tex	21	2	3	23.3	2
PACIFIC DRAINAGE					
Willamette, Eugene, Oreg	12	30	(2)	14.0	30
Santiam, Jefferson, Oreg	10	30	30	12.0	30

[1] Continued from last month.
[2] Continued at end of month.
[3] Estimated.

MEAN LAKE LEVELS DURING NOVEMBER, 1926

By UNITED STATES LAKE SURVEY

[Detroit, Mich., December 3, 1926]

The following data are reported in the Notice to Mariners of the above date:

Data	Lakes[1] Superior	Michigan and Huron	Erie	Ontario
Mean level during November, 1926:	Feet	Feet	Feet	Feet
Above mean sea level at New York	601.75	578.22	571.52	245.24
Above or below—				
Mean stage of October, 1926	+0.07	−0.10	−0.17	+0.31
Mean stage of November, 1925	+0.69	+0.54	+1.07	+0.93
Average stage for November, last 10 years	−0.48	−1.61	−0.14	−0.09
Highest recorded November stage	−1.76	−4.70	−2.15	−2.58
Lowest recorded November stage	+0.69	+0.54	+1.07	+1.83
Average departure (since 1860) of the November level from the October level	−0.17	−0.27	−0.26	−0.25

[1] Lake St. Clair's level: In November, 1926, 573.92 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, NOVEMBER, 1926

By J. B. KINCER

General summary.—During the first 10 days of the month the generally fair weather was favorable for field work, and good progress was made in seasonal farm operations, except that near the close of this period there was considerable interruption by widespread rains over the eastern half of the country. Temperatures were also favorable for drying out corn in the central valley States, and frost damage was of minor consequence. It continued too dry, however, in the west-central Great Plains, and moisture was needed in parts of the Southeast, while severe drought continued in the western Great Basin.

About the middle of the month generous to heavy rains in the Southeast relieved droughty conditions that had prevailed in much of that section, the rains being especially welcome in Virginia and the Carolinas. Widespread precipitation east of the Great Plains interrupted farm work during the middle portion of the month, but conditions continued especially favorable for livestock over the great western grazing districts.

In the interior valley States the latter part of the month had less precipitation and warmer weather than previously, which made better conditions for seasonal farm operations. In the South, the weather was generally favorable but in the more northern States from the Great Plains eastward cold weather and frequent precipitation were unfavorable. In the south Atlantic area the warm, dry, and sunny weather, following the previous rains, made ideal conditions for winter truck crops and cereals, and there was little interruption to field work. The droughty conditions in the west-central Great Plains continued at the close of the month, but generous to heavy precipitation in nearly all sections west of the Rocky Mountains was favorable.

Small grains.—Early-seeded winter wheat came up to a good stand generally in the central valley States and the Great Plains, and the month, on the whole was favorable for the crop, except that in the extreme western portion of the belt moisture was deficient. About the middle of November precipitation benefited the lower Missouri Valley, and the increased moisture in the far Northwest improved wheat, especially in the North Pacific Coast States. In the eastern Wheat Belt the crop made rather slow growth during the middle and latter parts of the month, but the early-seeded generally did well.

Corn.—During the first part of November the corn crop dried out very well under the influence of the prevailing fair weather, but after the first week rain or snow over much of the belt was unfavorable, and the grain was too damp in many sections for proper cribbing. Some further molding in fields and cribs was reported from the Ohio Valley States, but housing progressed favorably in the Northwest and also in the western portions of the Corn Belt. During the latter part of the month the generally warm weather and occasional rain kept the fields soft and muddy in the East, and husking made rather slow progress, with some sections reporting further deterioration in quality.

Cotton.—Freezing weather in the northeastern portion of the Cotton Belt early in the month damaged some

late cotton bolls and stopped further development, but conditions generally were favorable for picking and ginning, and this work made good progress. Later in the month it was unfavorably cool, cloudy, and wet in the northwestern portion of the belt, and picking was interrupted, especially in Arkansas and eastern Oklahoma where considerable open cotton was blown out by high winds. At the close of the month the crop had been mostly gathered, except in the more northern districts, though there was considerable still out in the northwestern portion of the belt.

Miscellaneous crops.—In the central and eastern portions of the country meadows and pasture lands continued generally good for the season, but in the more western States unfavorable drought persisted and heavy feeding of livestock was necessary in some sections. The weather was favorable for truck in the winter trucking districts, while citrus fruits in Florida were favorably affected by prevailing conditions. The latter part of the month was favorable for sugar cane in Louisiana, especially where windrowed, but harvest made good advance.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November, 1926

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	50.6	−3.5	2 stations	83	26	Valley Head	20	[2] 11	4.92	+1.84	Mobile	8.40	Evergreen	1.35
Arizona	53.6	+2.1	6 stations	91	[2] 4	Bright Angel	0	15	0.22	−0.71	Bright Angel	1.73	31 stations	0.00
Arkansas	47.2	−4.4	Corning	81	6	Dutton	10	19	3.33	−0.32	Black Rock	5.59	Amity	0.87
California	56.6	+4.2	Indio	101	7	Helm Creek	−2	13	7.69	+5.23	Upper Mattole	35.65	4 stations	0.00
Colorado	35.4	+0.7	2 stations	78	5	Dillon	−15	18	0.96	+0.10	Savage Basin	4.70	Rush	0.00
Florida	62.6	−2.1	Saint Cloud	91	1	Garniers	24	19	3.12	+0.82	Garniers	6.15	Fort Pierce	0.71
Georgia	51.7	−2.8	2 stations	87	8	Clayton	15	6	3.68	+1.03	Clayton	6.85	Augusta	1.74
Idaho	39.4	+3.9	Rupert	73	5	Stanley	−1	17	4.05	+2.11	Pyle Creek	11.26	Mud Lake	0.36
Illinois	37.7	−4.4	Harrisburg	71	14	White Hall	1	22	3.79	+1.37	Elgin	6.42	Danville	1.48
Indiana	39.5	−2.7	Vevay	78	15	Mount Vernon	5	22	2.10	−0.99	Thayer	4.41	Huntington	0.89
Iowa	32.6	−4.0	3 stations	71	[2] 5	Little Sioux	−3	21	2.10	+0.54	Davenport	3.88	Grinnell	0.68
Kansas	40.3	−3.8	2 stations	82	6	Horton (near)	3	21	1.42	+0.24	Hutchinson	3.74	Elkhart	0.25
Kentucky	42.9	−3.4	Dix Dam	80	14	Glasgow	0	22	3.41	−0.12	Junction City	5.57	Lockport	1.23
Louisiana	54.8	−4.1	Schriever	84	14	Tallulah	20	19	3.76	+0.27	Angola	6.37	Burrwood	1.37
Maryland-Delaware	43.3	−1.3	Rock Hill, Md	78	15	2 stations	7	12	4.33	+1.79	Emmitsburg, Md	7.54	Friendship, Md	2.19
Michigan	33.6	−2.7	2 stations	68	[2] 14	2 stations	−9	11	3.74	+1.27	Kent City	6.68	Saint James	0.97
Minnesota	23.9	−6.2	New Ulm	66	[2] 5	Warroad	−28	27	1.56	+0.40	Pigeon River Bridge	4.50	Alexandria	0.24
Mississippi	50.7	−4.4	Bay Saint Louis	82	26	3 stations	20	[2] 19	4.26	+0.79	Bay Saint Louis	6.12	Poplarville	1.99
Missouri	39.6	−4.9	Marshall	78	25	Bethany	0	21	2.98	+0.63	Williamsville	6.18	Bethany	0.77
Montana	32.2	+0.4	Sun River Canyon	76	5	Busby	−22	21	1.52	+0.66	Hebgen Dam	6.28	Conrad	0.08
Nebraska	33.8	−2.9	Dumas	79	5	2 stations	−13	21	1.54	+0.80	Virginia	4.57	Taylor	T.
Nevada	45.7	+5.0	2 stations	86	[2] 6	Rye Patch	8	14	1.47	+0.91	Carson City	5.28	Logandale	0.11
New England	38.2	+0.5	2 stations	72	18	Pittsburg, N. H	−5	28	4.85	+1.41	Gardiner, Me	9.28	Garfield, Vt	2.33
New Jersey	42.5	−0.4	2 stations	76	[2] 9	Belleplain	8	[2] 12	4.04	+0.93	Chatham	7.19	Atlantic City	2.44
New Mexico	43.9	+1.0	Logan	83	16	2 stations	−1	[2] 15	0.17	−0.44	Dulce	1.43	36 stations	0.00
New York	38.3	+0.7	Ohioville	74	8	Lake Placid Club	−4	28	4.09	+1.22	2 stations	7.25	Chazy	1.25
North Carolina	47.4	−2.2	Rockingham	80	14	Banners Elk	8	22	4.22	+1.83	Highlands	7.78	Lumberton	1.99
North Dakota	21.5	−5.1	2 stations	68	[2] 5	Valley City	−23	26	0.65	+0.07	Larimore	2.00	Lisbon	T.
Ohio	40.3	−1.2	Middleport	77	15	McArthur	11	12	2.15	−0.48	Toboso	4.09	New Bremen	0.21
Oklahoma	47.5	−2.9	Sulphur	85	25	Goodwell	8	20	1.05	−1.11	Wyandotte	5.28	Walters	0.00
Oregon	44.7	+3.5	Marshfield	78	1	Blitzen	8	13	7.52	+2.76	Valsetz	26.76	Blitzen	1.50
Pennsylvania	40.4	−0.6	2 stations	79	15	Saegerstown	−1	12	4.49	+1.68	South Sterling	9.84	Newell	2.00
South Carolina	50.0	−3.6	Georgetown	85	8	Santuck	17	12	3.05	+0.74	Caesar's Head	6.11	Aiken	1.36
South Dakota	29.0	−4.6	Ottumwa	75	5	Elm Springs	−14	21	0.78	+0.15	Sioux Falls	2.55	McIntosh	T.
Tennessee	44.4	−4.2	Sevierville	78	14	2 stations	12	[2] 22	5.07	+1.73	Decatur	7.20	Halls	2.80
Texas	55.1	−2.0	Victoria	91	7	2 stations	12	18	1.38	−0.96	Lufkin	4.60	8 stations	0.00
Utah	41.4	+4.2	Leeds (near)	88	7	2 stations	2	[2] 15	1.40	+0.44	Silver Lake	8.82	Hanksville	0.00
Virginia	44.2	−2.2	Diamond Springs	79	9	Burkes Garden	0	22	4.41	+1.99	Mount Weather	7.07	Newport News	1.82
Washington	42.4	+2.8	La Center	74	1	Republic	10	20	5.57	+0.56	Cushman Dan	21.09	Port Townsend	1.10
West Virginia	40.7	−2.0	Fairmont	82	15	Bayard	4	12	3.59	+0.84	Sutton	6.67	Bluefield	1.59
Wisconsin	28.4	−5.2	2 stations	67	[2] 6	Rest Lake	−10	11	2.96	+1.16	Plum Island	7.53	Ladysmith	1.09
Wyoming	34.0	+2.0	Pinebluff	75	4	South Pass City	−21	17	1.04	+0.49	Moran	5.79	Barnum	0.00
Alaska (October)	39.8	+3.8	Wonder Lake	73	12	Candle	−8	31	10.66	+1.60	Latouche	34.75	Fairbanks	0.23
Hawaii	72.6	+0.8	2 stations	92	[2] 5	Kula Sanitarium	47	[2] 16	3.99	−4.54	Honomanu Valley	16.55	13 stations	0.00
Porto Rico	77.1	+0.4	Comerio Falls	96	12	Aibonito	53	22	4.30	−2.91	Maricao	11.45	Mona Island	0.34

[1] For description of tables and charts, see REVIEW, January, 1926, p. 32.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1926*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							**40.8**	**+1.3**										**78**	**4.50**	**+0.9**										**6.1**		
Eastport	76	67	85	29.99	30.07	+.06	38.0	+1.3	57	16	44	14	28	32	28	37	35	84	3.47	−0.6	12	9,759	s.	44	e.	19	5	5	20	7.4	0.2	0.0
Greenville, Me	1,070	6	....	28.87	30.06	....	30.8	....	59	16	39	3	28	23	29	....	....	....	5.38	....	13	5,724	se.	36	se.	16	2	6	22	....	5.5	....
Portland, Me	103	82	117	29.98	30.11	+.10	39.4	+1.4	64	10	47	18	28	32	35	36	32	77	6.13	+2.3	13	6,227	w.	48	s.	16	12	2	16	6.0	T.	0.0
Concord	289	70	79	29.76	30.09	+.03	37.9	+0.2	68	16	46	14	28	29	35	....	....	....	5.62	+2.2	11	4,021	nw.	29	se.	16	8	7	15	6.5	T.	0.0
Burlington	403	11	48	29.58	30.03	−.02	36.6	+0.3	69	16	44	7	28	29	37	....	....	....	2.79	+0.2	10	10,424	s.	60	s.	16	1	9	20	8.4	1.1	T.
Northfield	876	12	60	29.10	30.08	+.03	33.8	+1.0	65	16	42	5	28	25	39	31	28	82	3.16	+0.6	14	5,967	s.	40	s.	16	1	11	18	8.3	10.3	0.0
Boston	125	115	188	29.96	30.10	+.05	44.2	+2.2	71	16	52	20	28	36	34	40	36	74	4.07	0.0	9	7,384	sw.	48	s.	16	10	10	10	5.1	T.	0.0
Nantucket	12	14	90	30.09	30.10	+.05	45.0	+0.6	62	16	51	27	28	38	26	43	41	86	3.05	−0.2	11	11,669	w.	49	sw.	10	8	13	9	5.2	0.0	0.0
Block Island	26	11	46	30.06	30.10	+.04	45.4	+0.8	62	16	51	24	28	40	27	42	38	76	5.15	+1.3	9	14,749	nw.	60	nw.	27	10	7	13	5.6	T.	0.0
Providence	160	215	251	29.93	30.11	+.04	42.9	+2.5	66	16	51	20	28	35	31	39	33	71	5.30	+1.4	11	9,500	nw.	56	nw.	27	14	8	8	4.6	0.0	0.0
Hartford	159	122	....	29.93	30.11	+.03	42.2	+2.7	68	16	50	19	28	34	31	....	....	....	6.22	+2.4	10	....	s.	....	....	....	11	7	12	5.3	0.0	0.0
New Haven	106	74	153	30.00	30.12	+.05	43.4	+1.4	64	16	52	21	28	35	29	39	35	74	4.48	+0.9	10	7,217	w.	50	se.	16	10	11	9	5.1	T.	0.0
Middle Atlantic States							**44.2**	**−0.5**										**76**	**3.95**	**+1.1**										**5.8**		
Albany	97	102	115	29.98	30.09	+.01	41.4	+2.1	68	16	49	15	28	34	34	38	35	83	3.24	+0.4	10	6,117	s.	48	se.	16	8	5	17	6.8	T.	0.0
Binghamton	871	10	84	29.12	30.07	−.02	39.9	+1.2	68	9	48	18	12	32	34	....	....	....	4.44	+2.2	12	5,676	sw.	30	nw.	10	2	8	20	8.1	1.4	0.0
New York	314	414	454	29.77	30.12	+.03	44.0	−0.2	65	9	51	23	28	37	30	40	34	70	3.12	−0.3	9	13,843	nw.	70	s.	16	7	12	11	5.9	T.	0.0
Harrisburg	374	94	104	29.72	30.14	+.03	42.0	−0.8	69	9	49	22	28	35	27	37	32	70	4.71	+2.4	7	5,379	nw.	33	se.	16	5	8	17	6.9	T.	0.0
Philadelphia	114	123	190	30.01	30.14	+.04	46.4	+0.7	73	8	54	24	28	39	27	42	38	78	3.07	0.0	9	6,410	sw.	45	sw.	16	9	7	14	5.9	T.	0.0
Reading	325	81	98	29.76	30.12	....	43.8	....	73	9	52	22	28	36	29	39	35	76	3.26	−0.1	7	5,695	se.	36	se.	16	7	7	16	6.4	T.	0.0
Scranton	805	111	119	29.22	30.10	+.01	40.7	+0.2	69	9	48	19	28	33	33	38	35	83	4.69	+2.4	9	5,954	s.	36	se.	16	5	4	21	7.8	T.	0.0
Atlantic City	52	37	172	30.08	30.14	+.04	46.2	+0.6	63	16	53	24	28	39	28	42	38	73	2.44	−0.8	8	13,169	w.	72	se.	16	14	7	9	4.3	0.0	0.0
Cape May	17	13	49	....	....	....	46.8	−0.6	65	8	54	23	28	40	26	....	....	....	3.54	+0.3	6	....	nw.	....	....	....	....	....	....	....	0.0	0.0
Sandy Hook	22	10	55	30.10	30.12	....	44.3	....	64	9	50	26	28	38	25	40	36	74	2.99	....	7	12,581	w.	65	sw.	16	10	11	9	5.5	T.	0.0
Trenton	190	159	183	29.91	30.12	....	43.7	....	71	9	53	22	28	35	30	39	35	78	4.79	+1.4	8	8,202	nw.	49	s.	16	10	10	10	5.2	T.	0.0
Baltimore	123	100	215	30.00	30.13	+.02	45.6	−0.7	70	15	53	26	28	38	30	40	35	71	6.46	+3.5	8	7,697	sw.	48	se.	16	8	13	9	5.6	T.	0.0
Washington	112	62	85	30.01	30.14	+.02	45.1	−0.1	73	9	54	24	12	36	28	39	34	72	5.29	+2.6	7	4,840	nw.	40	nw.	10	9	8	13	5.7	0.0	0.0
Cape Henry	18	8	54	30.10	30.12	....	51.0	....	74	9	57	32	23	45	28	47	43	78	4.43	+1.7	8	9,945	nw.	42	sw.	26	15	7	8	4.6	0.0	0.0
Lynchburg	681	153	188	29.39	30.16	+.03	44.0	−3.2	71	9	54	19	12	34	37	38	34	73	3.43	+0.6	8	4,302	nw.	29	nw.	10	12	9	9	5.0	T.	0.0
Norfolk	91	170	205	30.04	30.14	+.03	51.4	0.0	75	15	60	32	28	43	28	46	41	75	2.59	−0.1	9	9,434	n.	58	s.	16	13	8	9	4.4	T.	0.0
Richmond	144	11	52	30.00	30.15	+.03	46.4	−1.9	77	9	57	24	12	36	33	41	38	80	3.63	+1.2	10	5,507	ne.	36	sw.	9	12	8	10	4.7	T.	0.0
Wytheville	2,304	49	55	27.70	30.15	+.02	39.3	−3.7	67	9	48	16	12	30	34	35	32	79	3.96	+0.9	8	5,340	w.	31	e.	15	11	5	14	5.9	T.	0.0
South Atlantic States							**51.9**	**−2.3**										**76**	**3.00**	**+0.3**										**4.4**		
Asheville	2,253	70	84	27.74	30.16	+.02	41.4	−3.7	68	9	51	18	12	32	36	37	32	75	3.51	+1.2	9	7,577	nw.	33	n.	15	15	4	11	4.7	T.	0.0
Charlotte	779	55	62	29.29	30.14	+.01	47.8	−2.8	73	14	58	26	12	38	30	41	36	70	2.87	0.0	8	3,317	ne.	27	w.	26	16	4	10	4.4	0.0	0.0
Hatteras	11	11	50	30.11	30.12	+.01	55.8	−0.5	75	18	62	38	22	50	22	52	49	82	5.04	+0.4	12	10,650	n.	60	se.	16	12	7	11	4.9	0.0	0.0
Raleigh	376	103	110	29.74	30.15	+.02	48.8	−2.2	75	9	59	25	12	38	30	44	40	77	3.31	+1.0	7	5,491	ne.	41	w.	26	16	3	11	4.1	0.0	0.0
Wilmington	78	81	91	30.06	30.14	+.02	53.6	−2.4	77	9	64	30	12	43	33	48	45	78	2.86	+0.4	8	5,195	n.	35	sw.	16	13	8	9	4.3	0.0	0.0
Charleston	48	11	92	30.08	30.13	+.01	55.8	−2.3	76	9	64	36	12	48	24	51	47	76	1.90	−1.0	6	6,636	ne.	28	sw.	26	11	13	6	4.2	0.0	0.0
Columbia, S. C	351	41	57	29.76	30.16	+.04	51.2	−2.8	79	15	61	28	12	41	34	44	39	71	1.58	−0.6	6	4,493	n.	30	sw.	26	14	9	7	4.2	0.0	0.0
Due West	711	10	55	29.37	30.16	....	47.6	....	72	15	57	26	20	38	31	....	....	....	3.02	....	8	6,122	w.	40	sw.	26	13	9	8	4.3	0.0	0.0
Greenville, S. C	1,039	139	146	29.01	30.13	....	47.2	−2.4	68	15	56	27	11	39	24	41	36	71	4.63	....	9	6,230	ne.	44	sw.	26	17	3	10	3.9	0.0	0.0
Augusta	182	62	77	29.94	30.14	+.01	52.5	−2.0	78	15	63	30	12	42	35	47	45	83	1.74	−1.2	11	3,874	nw.	36	s.	15	13	8	9	4.3	0.0	0.0
Savannah	65	150	194	30.06	30.13	+.01	56.4	−2.1	78	15	65	33	12	48	24	50	46	75	3.78	+1.4	7	7,934	ne.	35	w.	16	13	8	9	4.6	0.0	0.0
Jacksonville	43	209	245	30.07	30.12	+.02	60.0	−2.2	80	8	68	37	11	52	23	54	50	75	3.37	+1.2	6	8,473	n.	39	w.	16	12	9	9	4.8	0.0	0.0
Florida Peninsula							**70.3**	**−0.7**										**78**	**1.39**	**−0.9**										**4.3**		
Key West	22	10	64	30.01	30.03	+.01	73.6	−0.7	86	3	78	60	20	69	13	68	66	81	0.80	−1.6	4	7,961	ne.	41	nw.	16	15	7	8	4.2	0.0	0.0
Miami	25	71	79	30.02	30.05	....	72.2	+0.2	85	3	78	54	21	66	21	66	63	75	1.84	−1.0	6	5,621	se.	30	se.	14	10	11	9	5.2	0.0	0.0
Tampa	35	79	87	30.05	30.09	+.01	65.2	−1.7	84	1	74	41	20	56	26	58	55	77	1.52	−0.2	7	4,756	n.	25	nw.	16	15	11	4	3.7	0.0	0.0
Titusville	44	5	....	30.04	30.09	....	65.3	....	86	9	75	40	20	56	30	....	....	....	2.68	....	7	....	nw.	....	....	....	16	5	9	4.2	0.0	0.0
East Gulf States							**52.3**	**−3.9**										**73**	**4.50**	**+1.0**										**4.7**		
Atlanta	1,173	190	216	28.88	30.14	+.01	47.2	−4.9	74	26	56	25	11	39	26	42	36	71	3.75	+0.4	11	9,203	nw.	48	w.	26	12	6	12	5.2	0.0	0.0
Macon	370	78	87	29.74	30.14	+.01	51.2	−3.0	77	26	62	29	11	41	32	45	40	73	3.65	+0.6	9	4,676	n.	26	sw.	26	14	7	9	4.4	T.	0.0
Thomasville	273	49	58	29.83	30.13	+.01	56.0	−2.5	79	14	66	32	19	45	29	48	44	74	4.02	+1.4	9	3,107	n.	17	nw.	16	12	9	9	4.4	0.0	0.0
Apalachicola	36	42	49	30.08	30.12	....	57.3	....	76	26	65	36	19	50	21	52	49	79	3.28	....	7	6,586	n.	32	se.	15	17	8	5	3.6	0.0	0.0
Pensacola	56	149	185	30.07	30.13	+.02	56.1	−4.1	74	8	64	33	11	48	24	50	47	76	3.80	+0.1	8	9,768	n.	44	s.	17	15	6	9	4.4	0.0	0.0
Anniston	741	9	57	29.35	30.16	+.04	47.6	−4.3	76	26	58	24	11	37	37	....	....	....	4.74	+1.3	11	4,128	nw.	30	w.	26	9	11	10	5.3	0.0	0.0
Birmingham	700	11	48	29.37	30.16	+.04	49.2	−4.7	75	26	59	25	11	39	31	42	37	71	5.04	+1.6	10	5,487	n.	36	se.	17	12	9	9	4.7	T.	0.0
Mobile	57	125	161	30.08	30.14	+.03	55.4	−3.2	81	26	64	33	11	46	28	49	44	73	8.40	+4.7	8	7,633	n.	39	nw.	17	12	9	9	4.7	0.0	0.0
Montgomery	223	100	112	29.90	30.16	+.04	52.4	−3.4	79	26	62	29	11	43	29	46	40	71	5.30	+2.2	7	5,049	n.	30	w.	26	14	8	8	4.5	0.0	0.0
Corinth	469	6	....	....	....	....	46.7	....	74	25	57	22	11	36	33	....	....	....	5.27	....	11	....	s.	....	....	....	6	15	9	....	T.	0.0
Meridian	375	87	95	29.74	30.14	+.02	50.3	−3.9	76	26	61	25	19	40	33	44	40	76	4.85	+0.7	7	4,231	nw.	30	s.	17	12	5	13	5.3	0.0	0.0
Vicksburg	247	65	73	29.87	30.16	+.04	51.6	−5.0	77	25	61	30	11	42	29	45	40	69	3.08	−1.1	8	5,430	se.	28	w.	17	13	8	9	4.8	0.0	0.0
New Orleans	53	76	84	30.08	30.14	+.04	57.8	−3.8	79	26	66	37	11	50	25	51	47	74	2.92	−0.9	8	4,900	ne.	25	sw.	17	13	7	10	4.6	0.0	0.0
West Gulf States							**55.7**	**−2.0**										**69**	**1.76**	**−1.5**										**4.3**		
Shreveport	249	77	93	29.86	30.14	+.03	53.6	−2.4	77	25	63	29	18	44	29	47	41	69	2.42	−1.7	9	5,343	se.	33	w.	17	16	5	9	4.2	0.0	0.0
Bentonville	1,303	11	44	....	....	....	42.6	−4.1	72	25	53	17	22	32	33	....	....	....	2.79	....	10	5,107	s.	32	s.	25	14	6	10	....	8.7	0.0
Fort Smith	457	79	94	29.58	30.07	−.04	47.8	−3.2	77	25	58	25	22	38	33	41	36	72	1.41	−1.9	4	7,005	e.	53	sw.	25	12	5	13	5.4	T.	0.0
Little Rock	357	136	144	29.71	30.10	−.02	47.8	−4.3	71	25	57	25	19	39	28	41	35	66	3.16	−1.4	8	7,252	s.	46	w.	17	11	6	13	5.5	0.1	0.0
Austin	605	136	148	29.49	30.13	....	57.0	....	81	25	68	31	18	46	35	....	....	....	2.94	....	5	6,593	nw.	39	nw.	8	15	9	6	4.1	0.0	0.0
Brownsville	57	53	61	30.02	30.08	....	65.8	−1.4	85	14	75	41	22	57	30	59	55	78	0.30	....	4	6,297	s.	33	n.	17	15	7	8	4.5	0.0	0.0
Corpus Christi	20	11	78	30.10	30.12	+.05	63.6	−0.7	83	25	72	39	18	56	29	57	53	75	0.35	−2.1	2	8,180	n.	38	n.	2	15	10	5	3.9	0.0	0.0
Dallas	512	220	227	29.55	30.10	....	54.0	....	85	25	64	26	22	44	31	....	....	....	0.95	....	3	11,566	se.	64	w.	8	15	9	6	3.7	0.0	0.0
Fort Worth	670	106	114	29.36	30.09	−.01	55.4	−0.1	86	25	67	27	18	44	33	45	38	59	0.73	−1.8	3	6,619	s.	42	w.	8	14	10	6	4.0	0.0	0.0
Galveston	54	106	114	30.08	30.14	+.05	60.9	−2.4	76	29	66	43	18	55	23	55	51	74	1.81	−2.2	7	8,862	se.	38	nw.	17	14	8	8	4.1	0.0	0.0
Groesbeck	461	11	56	29.63	30.12	....	54.5	....	80	25	65	27	22	44	36	....	....	....	2.29	....	5	8,480	s.	44	sw.	25	14	7	9	4.5	0.0	0.0
Houston	138	292	314	29.98	30.14	....	59.6	−1.4	79	25	68	37	18	51	26	....	....	....	2.27	....	9	10,917	se.	48	nw.	17	14	10	6	4.0	0.0	0.0
Palestine	510	64	72	29.58	30.12	+.01	54.8	−2.4	78	25	65	27	18	45	31	47	40	65	2.02	−1.6	6	6,452	s.	36	s.	25	14	5	11	4.7	0.0	0.0
Port Arthur	34	58	66	30.09	30.13	....	58.0	....	78	29	67	35	18	50	24	....	....	....	2.71	....	8	6,381	se.	34	nw.	17	15	3	12	4.7	0.0	0.0
San Antonio	693	119	132	29.38	30.12	+.04	59.6	−0.7	82	28	70	36	18	49	32	50	43	62	1.99	+0.2	4	6,049	s.	44	nw.	17	15	10	5	3.4	0.0	0.0
Taylor	583	55	63	29.53	30.15	+.07	56.4	−1.3	82	25	67	32	18	46	35	....	....	....	1.91	−0.7	4	6,828	s.	31	s.	16	15	10	5	4.0	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, October, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
							42.2	-3.0										72	3.07	-0.4										6.9		
Chattanooga	762	189	213	29.32	30.15	+.01	46.2	-4.2	68	14	56	27	11	37	30	40	34	69	6.22	+2.6	11	5,454	w.	40	w.	26	10	9	11	5.4	0.2	0.0
Knoxville	995	102	111	29.06	30.14	+.01	44.2	-3.7	74	14	54	25	12	35	30	40	36	78	4.61	+1.0	9	4,155	ne.	42	sw.	15	14	8	8	5.0	T.	0.0
Memphis	399	76	97	29.68	30.11	-.01	47.2	-4.5	71	25	55	25	22	39	22	42	36	68	4.23	-0.4	10	5,946	sw.	46	w.	26	11	6	13	5.7	0.2	0.0
Nashville	546	168	191	29.55	30.14	+.02	44.2	-4.8	69	25	54	21	22	35	30	39	35	73	4.64	+0.8	9	7,374	s.	44	se.	17	8	9	13	6.2	0.3	0.0
Lexington	989	193	230	29.02	30.12	.00	40.8	-4.0	70	14	49	16	22	33	35				3.21	-0.3	10	11,314	sw.	52	sw.	26	10	7	13	5.7	2.8	0.0
Louisville	525	188	234	29.52	30.12	.00	42.2	-4.5	70	14	51	18	22	34	32	37	32	70	1.83	-2.4	9	9,026	se.	42	s.	26	5	8	17	6.9	1.5	0.0
Evansville	431	76	116	29.63	30.11	-.01	41.8	-4.8	69	14	50	17	22	34	28	37	32	71	3.75	-0.4	11	7,789	s.	40	sw.	26	4	14	12	6.4	4.8	0.0
Indianapolis	822	194	230	29.15	30.06	-.04	39.2	-3.1	66	14	47	18	22	31	29	34	30	74	1.67	-1.8	13	10,189	s.	42	nw.	26	3	8	19	7.5	0.3	0.0
Royal Center	736	11	55	29.20	30.02		37.1		65	14	45	14	21	29	32				1.51		14	9,381	sw.	39	nw.	26	3	4	23	8.0	1.1	0.0
Terre Haute	575	96	129	29.41	30.05		39.9		67	14	48	18	22	32	33	35	31	77	2.22		12	8,770	s.	38	sw.	17	5	9	16	6.8	0.6	0.0
Cincinnati	627	11	51	29.40	30.10	-.02	41.0	-1.5	71	14	50	20	22	32	33	35	30	71	1.45	-1.8	9	6,861	sw.	36	s.	26	6	3	21	7.3	T.	0.0
Columbus	822	179	222	29.19	30.08	-.03	40.3	-1.6	68	14	48	22	22	33	29	36	32	75	2.22	-0.9	11	8,910	s.	50	nw.	26	3	6	21	7.9	1.4	0.0
Dayton	899	137	173	29.08	30.06		40.9	-1.1	69	14	49	20	22	33	29	35	30	69	1.41	-1.5	10	8,649	sw.	44	sw.	26	2	12	16	7.6	0.4	0.0
Elkins	1,947	59	67	28.03	30.15	+.03	39.3	-1.0	70	15	50	11	12	29	43	33	29	77	2.04	-0.8	13	4,927	w.	39	w.	16	7	4	19	7.6	1.6	0.0
Parkersburg	637	77	82	29.45	30.12	.00	42.4	-1.4	77	15	51	20	12	34	35	36	31	69	2.46	-0.4	11	4,909	se.	30	se.	15	4	5	21	8.0	0.2	0.0
Pittsburgh	842	353	410	29.17	30.10	.00	41.4	-1.8	75	15	49	23	11	34	30	37	32	73	3.27	+0.7	14	9,618	w.	48	w.	26	3	5	22	8.1	0.4	0.0
Lower Lake Region							39.2	-0.2										73	3.04	0.0										8.1		
Buffalo	767	247	280	29.16	30.01	-.04	39.7	+0.3	68	15	46	16	28	33	34	36	33	79	4.05	+0.7	17	14,422	sw.	72	sw.	9	1	8	21	8.4	4.8	0.0
Canton	448	10	61	29.51	30.00		35.3	+1.4	68	15	44	1	28	26	49				3.95	+0.5	14	9,061	sw.	49	sw.	10	1	11	18	8.1	7.2	T.
Oswego	335	76	91		30.03	-.02	39.8	+0.9	66	15	46	9	28	33	33			76	4.58	+1.2	14	9,524	sw.	38	w.	27	0	6	24		13.5	0.0
Rochester	523	86	102	29.45	30.03	-.02	40.0	+1.3	67	15	47	19	28	34	27	35	30	70	2.38	-0.4	16	7,133	sw.	35	w.	27	0	7	23	8.7	3.4	0.0
Syracuse	597	97	113	29.40	30.05	-.01	40.3	+1.6	67	9	47	11	28	34	34				3.71	+1.0	17	8,282	s.	45	s.	15	1	11	18	7.8	4.3	0.0
Erie	714	130	166	29.24	30.02	-.04	40.0	-1.4	71	15	47	22	28	34	29	36	30	68	3.74	+0.1	19	14,474	s.	50	se.	15	2	6	22	8.3	9.3	0.0
Cleveland	762	190	201	29.20	30.04	-.02	40.0	-0.9	70	15	47	21	22	33	33	36	30	70	2.56	-0.2	16	13,128	s.	49	s.	15	0	10	20	8.7	3.9	0.0
Sandusky	629	62	70	29.35	30.04	-.04	39.8	-1.3	70	14	47	19	22	32	32				1.55	-1.2	14	7,589	sw.	36	w.	26	0	13	17	7.7	1.5	0.0
Toledo	628	208	243	29.33	30.03	-.04	39.4	-1.0	66	14	47	19	22	32	29	34	29	70	1.31	-1.3	13	11,943	sw.	46	sw.	26	5	9	16	7.2	0.7	0.0
Fort Wayne	856	113	124	29.08	30.02		38.9	-1.7	66	14	47	18	22	31	27	35	31	78	1.54		15	8,114	sw.	37	w.	26	4	7	19	7.6	0.9	0.0
Detroit	730	218	258	29.20	30.01	-.05	38.2	-1.1	64	14	45	19	22	31	31	34	30	74	2.50	0.0	16	9,366	sw.	37	nw.	2	1	7	22	8.5	3.7	0.0
Upper Lake Region							32.4	-2.0										82	3.92	+1.5										8.5		
Alpena	609	13	92	29.28	29.96	-.05	32.4	-2.0	52	15	38	11	27	27	28	30	28	85	5.44	+2.9	21	9,928	sw.	52	se.	28	1	3	26	9.0	14.8	0.1
Escanaba	612	54	60	29.27	29.96	-.07	30.0	-3.1	48	15	35	10	11	25	21	28	25	82	3.81	+1.6	15	8,922	nw.	50	n.	9	3	5	22	8.1	13.8	4.0
Grand Haven	632	54	89	29.27	29.97	-.07	36.8	-1.7	64	14	43	20	27	31	30	34	31	82	3.63	+1.1	17	9,931	se.	42	nw.	26	1	5	24	8.8	6.9	0.0
Grand Rapids	707	70	87	29.19	29.98	-.07	37.4	-1.0	63	14	44	20	27	31	28	34	30	77	3.55	+1.0	16	5,356	nw.	30	nw.	26	0	5	25	9.1	6.6	0.0
Houghton	668	62	99	29.23	29.98	-.04	27.8	-4.2	49	15	32	11	27	24	16				5.05	+2.2	21	8,435	e.	40	nw.	26	0	1	29	9.8	38.0	15.5
Lansing	878	11	62	29.02	29.98		35.8	-1.7	62	14	43	13	11	28	28	33	31	87	2.93	+0.5	15	5,960	s.	31	nw.	26	1	9	20	8.1	3.4	0.0
Ludington	637	60	66	29.24	29.95		35.5		59	14	41	19	27	30	22	33	31	84	5.63		18	9,799	se.	43	n.	26	1	5	24	8.7	8.2	0.0
Marquette	734	77	111	29.14	29.96	-.06	28.8	-4.5	52	15	33	12	27	24	18	27	24	81	5.75	+3.0	21	9,003	w.	38	nw.	30	1	1	28	9.4	34.4	12.0
Port Huron	638	70	120	29.28	29.99	-.06	36.8	-0.7	60	15	44	17	27	30	31	34	30	80	2.68	0.0	14	10,013	sw.	48	nw.	2	2	12	16	7.3	2.1	0.0
Saginaw	641	69					35.2	-2.2	61	15	43	14	27	28	33				3.00		12		sw.				2	2	26		1.5	
Sault Sainte Marie	614	11	52	29.25	29.97	-.04	28.4	-3.6	52	15	34	-2	27	23	29	27	24	87	5.15	+2.2	21	7,478	se.	42	nw.	24	2	2	26	9.1	25.3	9.4
Chicago	673	7	131	29.24	29.99	-.08	37.0	-3.1	63	6	44	12	21	30	36	33	29	75	3.97	+1.5	11	9,920	s.	40	n.	9	4	6	20	7.8	3.9	0.0
Green Bay	617	109	141	29.28	29.96	-.08	30.0	-4.0	54	14	36	9	27	24	22	29	26	86	2.78	+0.8	15	8,674	nw.	38	n.	9	3	5	22	8.1	15.7	2.0
Milwaukee	681	125	139	29.21	29.97	-.08	34.2	-3.1	54	6	40	12	21	28	20	31	27	76	4.60	+2.6	12	8,231	w.	48	e.	18	5	5	20	7.6	13.8	T.
Duluth	1,133	5	47	28.75	30.02	-.02	22.6	-7.4	46	6	29	-5	30	16	32	21	18	86	1.62	0.0	9	10,756	nw.	42	nw.	30	5	6	19	7.6	8.7	5.6
North Dakota							22.2	-4.1										82	0.77	0.0										7.6		
Moorhead	940	50	58	29.01	30.07	.00	21.7	-5.4	58	5	29	-12	30	14	44	20	18	84	1.10	+0.1	12	7,381	n.	28	n.	30	5	7	18	7.4	10.6	6.7
Bismarck	1,674	8	57	28.25	30.10	+.03	24.7	-3.8	68	5	32	-8	30	18	40	21	17	75	0.51	-0.2	6	7,484	nw.	36	nw.	15	4	6	20	7.7	3.8	2.0
Devils Lake	1,478	11	44	28.45	30.10	+.04	18.8	-3.8	52	5	25	-17	30	12	30	17	15	86	0.69	0.0	11	8,510	n.	36	n.	30	5	6	19	7.4	8.1	3.6
Ellendale	1,457	10	56	28.44	30.06		23.2		63	5	31	-10	30	16	42				0.25		8	12,043	nw.	47	nw.	15	2	7	21	7.6	2.6	0.5
Grand Forks	833	12	67				20.4		56	5	28	-12	30	13	36				1.26		11		n.	38	nw.	15	1	12	17		12.7	
Williston	1,878	41	48	28.04	30.10	+.04	23.4	-3.8	62	5	30	-8	30	17	33	21	18	82	0.77	+0.2	11	5,778	se.	31	nw.	5	3	8	19	7.7	5.3	1.9
Upper Mississippi Valley							34.6	-3.8										78	3.15	+1.1										7.3		
Minneapolis	918	102	206	28.98	29.99		27.5	-4.9	60	5	34	7	27	21	30				1.82	+0.6	12	10,037	nw.	36	n.	18	3	8	19	7.6	4.9	1.0
St. Paul	837	236	261	29.05	29.99	-.07	27.2	-5.3	59	5	34	8	27	21	31				2.12	+0.8	12	10,440	nw.	37	nw.	18	4	6	20	7.5	7.1	1.7
La Crosse	714	11	48	29.17	29.96	-.11	30.9	-4.3	60	5	38	9	11	24	33				1.77	+0.2	12	4,700	se.	23	nw.	26	3	5	22	8.3	8.7	1.0
Madison	974	70	78	28.90	29.99	-.07	31.8	-3.4	58	7	38	10	21	25	25	29	26	83	3.63	+1.8	13	8,251	nw.	40	ne.	18	5	6	19	7.3	8.8	0.2
Wausau	1,247	4		28.59	29.96		27.2		52	14	33	4	27	21	23				2.07		15		n.				2	4	24	8.6	12.9	4.1
Charles City	1,015	10	49	28.89	30.00	-.08	30.1	-2.9	60	5	38	9	10	23	34	27	24	83	1.52	+0.1	11	6,491	nw.	26	nw.	26	5	7	18	7.5	3.7	T.
Davenport	606	71	79	29.32	30.00	-.08	35.2	-3.8	63	6	42	9	21	28	32	32	29	82	1.88	+2.1	11	6,140	nw.	25	n.	8	5	4	21	7.5	8.1	0.0
Des Moines	861	84	97	29.07	30.00	-.08	35.2	-3.2	66	5	43	13	10	27	37	32	28	74	2.43	+1.0	11	6,222	nw.	29	n.	8	5	7	18	7.2	2.2	0.0
Dubuque	700	81	96	29.20	29.97	-.08	32.9	-4.1	63	7	40	10	21	26	26	30	26	78	3.24	+1.4	10	5,809	nw.	30	n.	9	3	4	23	8.2	3.2	T.
Keokuk	614	64	78	29.33	30.03	-.06	37.8	-3.3	66	6	46	15	21	30	33	33	28	72	3.11	+1.3	9	6,967	nw.	35	sw.	25	6	10	15	7.0	6.3	0.0
Cairo	358	87	93	29.70	30.10	-.02	43.2	-4.1	71	25	52	24	10	35	33	38	33	71	4.49	+0.5	10	7,478	s.	46	sw.	25	6	10	14	6.5	0.5	0.0
Peoria	609	11	45	29.34	30.02	-.07	36.2	-1.3	64	6	44	10	21	29	33	33	30	82	5.41	+2.8	13	5,903	s.	25	nw.	9	5	8	17	7.3	10.7	0.0
Springfield, Ill	636	10	91	29.33	30.03	-.07	37.4	-4.8	64	7	44	13	22	30	28	34	30	78	4.52	+1.9	11	7,173	s.	30	w.	26	7	5	18	7.1	8.4	0.0
Hannibal	534	74	109	29.44	30.02	-.07	39.0	-3.1	66	6	47	12	21	28	29				3.49	+1.5	13	7,679	nw.	58	nw.	14	7	5	19	6.6	9.8	0.0
St. Louis	568	265	303	29.43	30.05	-.05	40.5	-4.6	67	6	48	17	22	32	33	35	31	72	2.71	-0.2	11	11,032	sw.	60	nw.	26	10	6	14	6.1	10.4	0.0
Missouri Valley							35.2	-3.8										75	1.75	+0.5										6.0		
Columbia, Mo	784	11	84	29.18	30.03	-.06	39.4	-3.9	71	25	48	9	22	31	37				2.38	+0.1	11	7,264	nw.	31	nw.	26	7	8	15	6.3	7.7	0.0
Kansas City	963	161	181	28.98	30.04	-.05	40.4	-3.3	70	25	49	14	21	32	35	35	30	70	1.08	-0.8	9	9,563	nw.	48	n.	9	11	8	11	5.5	1.1	0.0
St. Joseph	967	11	49	28.97	30.03		38.8		71	6	47	10	21	30	35	34	29	74	1.08		8	7,913	nw.	38	nw.	26	13	4	13	5.4	2.1	0.0
Springfield, Mo	1,324	98	104	28.62	30.05	-.05	40.5	-5.2	70	25	49	17	22	32	31	36	32	75	2.96	+0.3	10	9,292	s.	39	s.	25	13	5	12	5.3	7.6	0.0
Iola	984	11	50	28.97	30.05	-.04	41.1	-3.0	70	25	51	17	22	31	34				1.28	-0.2	6	6,333	s.	29	n.	8	8	11	11	5.8	T.	0.0
Topeka	987	92	107				40.0	-2.8	69	5	49	14	21	31	34				1.42	+0.2	6	8,483	sw.	44	n.	8	16	7	7	4.2	0.2	0.0
Lincoln	1,189	11	84	28.74	30.05	-.03	35.3	-3.8	72	5	44	7	21	27	37	31	26	73	3.76	+2.9	8	9,141	nw.	42	nw.	8	7	7	16	6.7	3.2	0.0
Omaha	1,105	115	122	28.82	30.04	-.04	34.3	-4.2	72	5	42	6	21	27	35	31	26	74	2.96	+1.9	7	7,948	nw.	38	n.	8	7	10	12	5.7	6.1	0.0
Valentine	2,598	47	54	27.28	30.08	-.06	31.6	-3.0	69	5	42	-4	21	21	38	27	23	78	0.90	+0.2	11	7,428	n.	37	s.	24	7	11	12	6.1	10.4	0.0
Sioux City	1,135	94	164	28.80	30.06	-.02	31.8	-3.4	70	5	39	10	21	24	38	29	25	77	1.32	+0.4	7	10,793	nw.	42	nw.	15	5	8	18	7.1	3.8	0.0
Huron	1,306	59	74	28.63	30.06		27.2	-4.3	68	5	36	0	30	19	41	24	20	76	0.21	-0.4	4	8,514	nw.	36	nw.	14	5	8	18	7.3	1.7	0.0
Pierre	1,572	70	75		30.09	+.01	29.8	-3.8	71	5	39	3	30	21	44			76	0.38	0.0	3	7,737	nw.	40	nw.	15	5	4	21		4.7	0.2
Yankton	1,283	49	57	28.08	30.04	-.04	30.4	-4.9	68	5	39	7	21	22	42				2.36	+1.6	9	7,426	nw.	34	nw.	15	4	9	17	7.2	4.4	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, October, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
Northern Slope							**32.9**	**+0.2**										**73**	**1.13**	**+0.3**										**6.9**		
Billings	3,140	5					34.6		66	5	46	-6	21	24	40				1.40		8		nw.				12	9	9		16.0	
Havre	2,505	11	44	27.37	30.09	+.06	25.9	-5.3	68	4	35	-12	21	17	39	23	19	81	1.17	+0.4	12	4,204	e.	28	n.	16	7	8	15	6.9	11.2	5.8
Helena	4,110	87	112	25.78	30.06	-.04	34.5	+1.3	62	5	42	4	19	27	29	30	25	71	1.52	+0.8	14	4,667	sw.	32	sw.	7	3	2	25	8.2	19.5	3.6
Kalispell	2,973	48	56	26.91	30.02	-.05	34.9	+2.5	52	10	41	11	20	29	23	32	29	82	2.01	+0.1	14	2,977	nw.	27	ne.	18	5	5	20	7.4	6.1	T.
Miles City	2,371	48	55	27.50	30.13	+.06	29.8	-1.1	64	5	39	-7	21	21	43	26	23	79	1.42	+0.8	10	4,024	ne.	36	nw.	16	7	7	16	6.5	8.4	4.0
Rapid City	3,259	50	58	26.60	30.12	+.04	31.6	-4.3	66	5	42	-5	21	21	45	28	24	75	0.96	+0.5	9	5,392	n.	39	nw.	2	4	6	20	7.5	6.8	0.0
Cheyenne	6,088	84	101	23.96	30.01	-.06	37.9	+3.1	58	5	47	12	20	28	35	30	22	56	0.52	+0.1	7	11,234	w.	55	w.	25	4	12	14	6.9	5.7	0.0
Lander	5,372	60	68	24.64	30.08	-.02	35.7	+5.4	58	5	46	9	17	25	33	29	22	63	0.13	-0.5	2	3,559	w.	40	w.	26	7	17	6	5.5	1.3	0.0
Sheridan	3,790	10	47	26.08	30.08		33.8		68	5	45	-8	21	23	43	28	23	70	1.22		9	3,642	nw.	40	nw.	16	5	12	13	6.2	8.6	0.4
Yellowstone Park	6,241	11	48	23.86	30.10	-.01	31.8	+2.5	53	4	39	5	20	24	31	28	25	78	2.07	+0.6	22	5,786	s.	44	s.	24	4	4	22	7.8	13.9	T.
North Platte	2,821	11	51	27.09	30.10	+.02	34.2	-2.4	72	5	45	5	21	24	41	28	24	75	0.33	-0.1	5	5,583	n.	36	nw.	14	8	6	16	6.4	1.2	0.0
Middle Slope							**42.2**	**-0.6**										**66**	**0.94**	**-0.1**										**5.0**		
Denver	5,292	106	113	24.71	30.02	-.04	42.8	+3.0	67	5	53	19	20	32	33	34	23	50	0.31	-0.2	4	6,314	s.	48	n.	16	9	12	9	5.3	2.3	0.0
Pueblo	4,685	80	86	25.29	30.03	-.02	43.0	+3.6	71	30	57	16	18	29	40	33	22	50	0.07	-0.3	2	5,753	nw.	48	w.	27	10	16	4	4.7	T.	0.0
Concordia	1,392	50	58	28.54	30.05	-.03	38.6	-2.8	72	5	48	16	21	29	34	32	27	72	1.48	+0.5	6	6,774	nw.	36	n.	8	7	11	12	6.2	0.2	0.0
Dodge City	2,509	11	51	27.47	30.08	+.01	40.4	-2.2	78	6	53	13	18	28	45	32	27	71	1.29	+0.7	5	7,178	nw.	41	nw.	8	17	5	8	4.0	4.4	0.0
Wichita	1,358	139	158	28.57	30.04	-.04	41.8	-3.0	72	6	51	19	18	33	34	36	31	72	1.63	+0.4	6	10,721	s.	46	s.	12	12	11	7	4.8	0.2	0.0
Broken Arrow	765	11	56	29.22	30.06		45.2		74	25	55	21	22	35	32				3.59		5	11,099	s.	46	s.	25	10	9	11	3.4	T.	0.0
Oklahoma City	1,214	10	47	28.76	30.07	-.01	46.8	-2.0	75	25	57	18	22	36	31	40	37	79	0.83	-1.4	5	8,786	s.	38	n.	8	11	10	9	4.7	1.1	0.0
Southern Slope							**51.5**	**-0.1**										**57**	**0.85**	**-0.3**										**3.8**		
Abilene	1,738	10	52	28.26	30.09	+.02	53.0	-0.5	81	25	65	23	22	41	37	42	33	57	0.68	-0.6	3	8,148	s.	44	w.	25	14	6	10	4.6	0.0	0.0
Amarillo	3,676	10	49	26.29	30.06	+.01	47.0	+1.5	76	6	60	20	21	34	44	36	28	58	0.29	-0.9	4	7,784	sw.	42	sw.	13	17	8	5	3.8	2.8	0.0
Del Rio	944	64	71	29.11	30.12	+.07	57.5	-2.5	80	27	68	33	18	47	38				2.30	+1.1	3	5,723	se.	39	n.	17	20	3	7	3.1	0.0	0.0
Roswell	3,566	75	85	26.41	30.06	+.03	48.6	+0.5	77	6	63	20	22	34	46	38	28	55	0.14	-0.7	3	5,807	s.	48	nw.	7	16	9	5	3.6	0.0	0.0
Southern Plateau							**51.8**	**+2.6**										**47**	**1.00**	**+0.4**										**2.8**		
El Paso	3,778	152	175	26.27	30.09	+.00	53.8	+1.1	76	27	66	29	18	41	36	41	29	44	0.15	-0.4	1	7,033	nw.	49	w.	16	20	9	1	2.5	0.0	0.0
Santa Fe	7,013	38	53	23.28	30.09	+.06	40.0	+1.1	62	6	52	19	17	29	31	30	20	50	0.13	-0.6	1	5,302	n.	43	nw.	16	20	9	1	2.9	T.	0.0
Flagstaff	6,907	10	59	23.42	30.07	+.05	40.1	+5.5	72	6	56	15	15	24	46	30		55	1.06		3	5,785	nw.	37	nw.	16	16	12	2		2.5	T.
Phoenix	1,108	10	82	28.87	30.03	+.05	61.6	+1.9	87	4	78	38	15	46	42	48	36	45	0.01	-1.0	1	2,984	e.	18	w.	13	17	9	4	3.1	0.0	0.0
Yuma	141	9	54	29.88	30.03	+.06	64.4	+2.0	89	7	80	43	18	49	42	50	36	41	0.00	-0.3	0	3,198	n.	23	w.	12	21	7	2	2.2	0.0	0.0
Independence	3,957	5	25	26.03	30.09	+.04	51.2	+4.0	78	1	67	28	14	36	45	39			4.69	+4.4	3		nw.				14	7	9	3.1	0.0	0.0
Middle Plateau							**44.2**	**+4.9**										**52**	**1.28**	**+0.5**										**5.4**		
Reno	4,532	74	81	25.51	30.05	-0.06	47.8	+6.8	74	6	60	25	14	35	44	38	29	52	2.31	+1.7	9	5,095	w.	41	sw.	24	8	12	10	5.4	T.	0.0
Tonopah	6,090	12	20	24.12	30.06		45.0		66	6	52	26	14	38	22	35	22	42	0.15		2		se.									
Winnemucca	4,344	18	56	25.68	30.11	-.03	43.8	+5.4	71	4	58	18	4	30	53	37	30	64	1.30	+0.6	12	5,919	sw.	38	w.	24	8	12	10	5.9	0.5	0.0
Modena	5,473	10	43	24.69	30.10	+.02	41.0	+4.6	71	6	57	13	17	25	45	30	18	48	0.70	+0.1	5	7,623	w.	46	sw.	24	14	10	6	4.2	0.1	0.0
Salt Lake City	4,360	163	203	25.69	30.10	-.02	46.6	+5.5	66	22	55	31	8	38	28	38	29	54	1.85	+0.4	9	4,912	se.	44	nw.	16	6	7	17	6.7	1.7	0.0
Grand Junction	4,602	60	68	25.47	30.10	+.02	41.6	+2.3	62	1	54	18	17	29	35	33	24	54	0.26	-0.3	5	3,520	nw.	36	nw.	16	11	14	5	4.6	T.	0.0
Northern Plateau							**43.3**	**+3.9**										**73**	**2.89**	**+1.6**										**7.2**		
Baker	3,471	48	53		30.07	-.09	40.5	+4.5	64	4	49	24	1	32	36			78	1.96	+0.8	14	4,434	se.	24	se.	11	5	4	21		T.	0.0
Boise	2,739	78	86	27.21	30.10	-.07	45.8	+4.8	63	1	54	29	17	37	31	40	34	65	3.21	+2.4	18	3,773	se.	29	se.	26	9	1	20	7.0	0.0	0.0
Lewiston	757	40	48	29.21	30.04	-.08	45.0	+3.6	65	10	53	28	4	37	29				4.15	+2.8	18	1,829	e.	21	w.	6	6	4	20	7.3	0.2	0.0
Pocatello	4,477	60	68	25.50	30.07	-.07	42.8	+6.1	66	5	52	23	8	34	33	36	29	64	1.53	+1.0	14	7,779	s.	48	sw.	16	8	4	18	6.9	T.	0.0
Spokane	1,929	101	110	27.95	30.03	-.07	40.5	+2.0	58	10	47	26	19	34	30	38	35	81	2.56	+0.5	16	3,575	ne.	27	s.	20	6	3	21	7.7	0.2	0.0
Walla Walla	991	57	65	28.94	30.02	-.11	45.1	+2.3	64	10	52	28	20	39	23	41	37	76	3.94	+1.8	18	3,115	s.	19	w.	6	5	5	20	7.3	4.5	0.0
North Pacific Coast Region							**50.7**	**+4.5**										**85**	**7.24**	**+0.7**										**7.8**		
North Head	211	11	56	29.66	29.89	-.16	51.6	+3.4	69	1	56	39	20	48	16	49	47	86	9.34	+3.0	22	13,094	e.	80	s.	26	3	2	25	8.7	0.0	0.0
Port Angeles	29	8	53	29.88	29.92		46.4		63	11	52	32	19	41	19				2.81	-1.6	18	3,128	sw.	31	w.	6	4	6	20	7.6	0.0	0.0
Seattle	125	215	250	29.78	29.92	-.12	49.4	+3.8	62	4	54	37	20	44	24	47	46	88	4.94	-0.4	19	5,521	se.	44	sw.	11	4	5	21	7.9	T.	0.0
Tacoma	194	172	201	29.71	29.92	-.12	49.4	+4.8	67	4	55	35	19	44	26				5.55	-1.0	19	4,575	s.	44	s.	11	0	12	18	8.2	T.	0.0
Tatoosh Island	86	9	53	29.76	29.86	-.11	50.6	+4.7	58	10	53	41	20	48	12	49	48	91	9.66	-2.4	22	15,584	e.	72	e.	20	6	4	20	7.2	0.0	0.0
Yakima	1,071	5					39.7		66	2	50	21	18	29	45				3.11		14		nw.				5	11	14	6.6	5.4	0.0
Medford	1,425	4					49.6		72	1	59	29	4	40	42	45	43	86	6.66		18		nw.				4	11	15		0.0	0.0
Portland, Oreg.	153	68	106	29.79	29.95	-.15	50.6	+3.8	69	1	56	36	19	45	25	47	43	80	9.78	+3.4	21	4,153	se.	23	s.	26	3	5	22	8.0	0.0	0.0
Roseburg	510	9	57	29.41	29.96	-.16	52.6	+6.7	71	20	60	35	1	45	32	49	46	82	8.59	+4.2	21	2,111	s.	23	sw.	24	2	5	23	8.6	0.0	0.0
Middle Pacific Coast Region							**58.3**	**+4.6**										**75**	**7.23**	**+4.2**										**6.0**		
Eureka	62	73	89	29.92	30.00	-.11	55.9	+4.8	73	20	62	40	3	50	21	53	51	85	13.65	+8.0	15	5,465	se.	45	sw.	25	1	7	22	8.1	0.0	0.0
Point Reyes	490	7	18	29.46	29.98		57.6	+4.6	79	9	63	46	4	53	24				6.33		11	14,840	s.	68	s.	25	7	10	13	6.4	0.0	0.0
Red Bluff	332	50	56	29.67	30.03	-.08	57.4	+3.6	83	8	66	39	14	48	38	51	45	60	7.39	+4.2	15	4,904	nw.	29	se.	26	7	9	14	6.2	0.0	0.0
Sacramento	69	106	117	29.97	30.04	-.05	58.6	+5.0	78	7	67	41	14	50	30	52	47	70	4.48	+2.3	11	5,315	se.	39	se.	26	10	9	11	5.0	0.0	0.0
San Francisco	155	208	243	29.87	30.04	-.05	60.9	+4.6	79	7	68	49	4	54	26	55	51	75	7.21	+4.7	13	4,948	se.	41	sw.	24	8	10	12	5.5	0.0	0.0
San Jose	141	12	110	29.91	30.06		59.3	+4.9	84	7	71	39	14	48	41				3.44	+2.0	10	4,721	s.	32	sw.	24	10	10	10	5.1	0.0	0.0
South Pacific Coast Region							**63.4**	**+5.4**										**59**	**3.72**	**+2.5**										**4.2**		
Fresno	327	89	98	29.72	30.08	+.02	60.9	+6.7	85	2	72	39	14	50	33	51	41	55	2.61	+1.6	8	3,290	e.	32	nw.	24	12	11	7	4.3	0.0	0.0
Los Angeles	338	159	191	29.69	30.06	+.04	67.0	+6.1	90	2	77	52	28	57	36	53	42	51	3.45	+2.0	5	3,766	ne.	28	w.	13	14	11	5	4.1	0.0	0.0
San Diego	87	62	70	29.95	30.04	+.02	63.8	+4.1	88	8	73	48	6	54	37	55	48	67	0.59	-0.2	4	3,521	nw.	23	w.	13	15	9	6	3.9	0.0	0.0
San Luis Obispo	201	32	40	29.86	30.08	+.02	61.8	+4.5	93	8	75	39	1	48	48	51	44	64	8.24	+6.5	8	2,347	n.	28	s.	24	15	6	9	4.4	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.82	29.90		78.5	+0.1	88	9	84	68	20	73	15				3.11	-3.8	17	7,296	e.	38	e.	16	8	15	7	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.72	29.84	.00	79.5	+0.4	91	29	86	70	8	73	18	75	74	89	9.63	-0.4	20	4,004	nw.	24	ne.	4	1	6	23	7.9	0.0	0.0
Colon	38	7	97	29.81	29.85	.00	80.0	+0.7	90	1	86	73	19	74	15	76	75	86	29.39	+8.1	26	5,573	sw.	27	w.	17	1	7	22	8.0	0.0	0.0
Alaska																																
Juneau	80	11	54	[1]29.74	[1]29.83		37.6		55	11	42	20	29	33	23	35	29	72	3.21		14	6,974	e.	41	e.	24	12	2	16	5.9	1.4	1.3
Hawaiian Islands																																
Honolulu	38	86	100	[1]30.00	[1]30.04		75.8		84	5	81	64	18	71	12	68	65	70	0.12	-3.7	6	5,804	ne.	48	e.	14	8	19	3	4.9	0.0	0.0

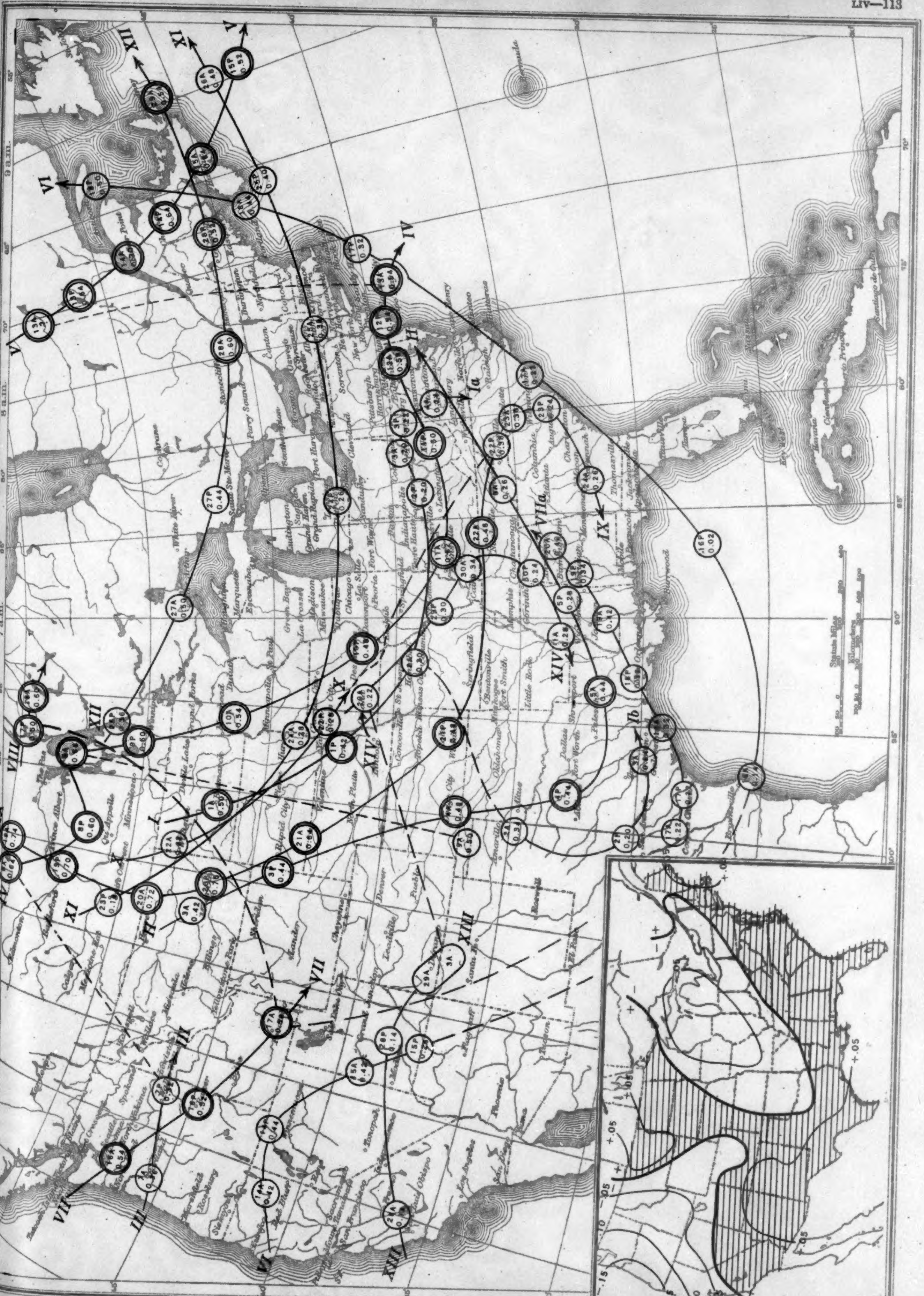
[1] Pressure not corrected to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian meteorological service, November, 1926*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*
St. Johns, N. F.	125												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	29.96	29.98	+0.02	30.3	+1.4	37.8	22.9	66	10	1.79	−1.32	9.9
Quebec, Que.	296	29.69	30.03	+.01	30.8	+1.8	37.2	24.5	63	3	3.57	−0.19	14.9
Montreal, Que.	187	29.79	30.01	−.02	33.4	+1.6	40.3	26.6	66	2	4.22	+0.48	15.1
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.75	30.03	+.01	32.8	+1.1	40.3	25.2	63	2	4.85	+2.31	13.0
Kingston, Ont.	285	29.70	30.02	−.02	36.7	+1.7	43.2	30.2	61	5	3.62	+0.38	0.6
Toronto, Ont.	379	29.58	30.00	−.04	37.4	+1.8	43.2	31.6	63	15	3.81	+0.67	0.7
Cochrane, Ont.	930				20.0		25.7	14.4	51	−17	1.70		11.0
White River, Ont.	1,244	28.60	29.96	−.02	17.4	−3.1	24.5	10.4	49	−34	5.04	+3.19	37.2
Port Stanley, Ont.	592												
Southampton, Ont.	656	29.23	29.96	−.06	35.0	0.0	40.8	29.2	62	13	6.90	+3.20	15.2
Parry Sound, Ont.	688	29.25	29.96	−.05	31.0	−1.1	38.3	23.7	60	2	7.04	+2.67	20.5
Port Arthur, Ont.	644	29.29	30.02	+.02	21.7	−2.3	27.3	16.1	42	−14	2.10	+0.77	18.4
Winnipeg, Man.	760												
Minnedosa, Man.	1,690	28.23	30.14	+.10	14.3	−3.0	19.7	8.9	38	−20	1.70	+0.70	17.0
Le Pas, Man.	860				11.0		18.7	3.3	40	−27	0.66		6.6
Qu'Appelle, Sask.	2,115	27.75	30.10	+.10	15.8	−3.0	21.0	10.6	54	−16	2.19	+1.30	20.1
Medicine Hat, Alb.	2,144	27.68	30.00	.00	27.8	+0.4	36.9	18.7	64	−10	0.95	+0.03	9.5
Moose Jaw, Sask.	1,759				19.6		25.2	14.0	64	−12	1.75		16.7
Swift Current, Sask.	2,392	27.42	30.05	+.03	21.7	−1.5	29.0	14.4	61	−6	0.77	+0.08	7.1
Calgary, Alb.	3,428	26.38	30.08	+.10	24.7	−1.1	33.3	16.1	62	−8	1.53	+0.65	4.9
Banff, Alb.	4,521	25.32	30.02	+.06	26.2	+0.4	34.4	18.0	51	−9	1.23	−1.04	12.3
Edmonton, Alb.	2,150	27.69	30.07	+.10	18.0	−4.9	24.6	11.4	57	−17	1.01	−0.43	9.6
Prince Albert, Sask.	1,450	28.55	30.21	+.18	14.4	−1.0	20.7	8.1	52	−31	0.77	−0.06	5.9
Battleford, Sask.	1,592	28.35	30.18	+.16	16.3	0.0	23.4	9.2	55	−14	0.80	+0.22	7.6
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.65	29.90	−.09	48.0	+4.8	51.8	44.2	60	38	3.16	−3.81	0.0
Barkerville, B. C.	4,180												
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	30.00	30.16	+.11	70.8	+2.1	77.1	64.6	84	61	10.10	+5.72	0.0

LATE REPORTS, OCTOBER, 1926

Calgary, Alb.	4,521	26.35	29.92	−.03	44.2	+4.1	55.2	33.3	76	22	0.74	+0.26	1.0
Kamloops, B. C.	1,262	28.72	30.02	+.06	48.6	+1.6	57.3	39.9	70	26	0.84	+0.23	0.0
Barkerville, B. C.	4,180	25.63	29.95	+.01	38.5	−1.2	46.1	30.9	55	21	3.71	+1.01	2.8


(Plotted by Wilfred P. Day)

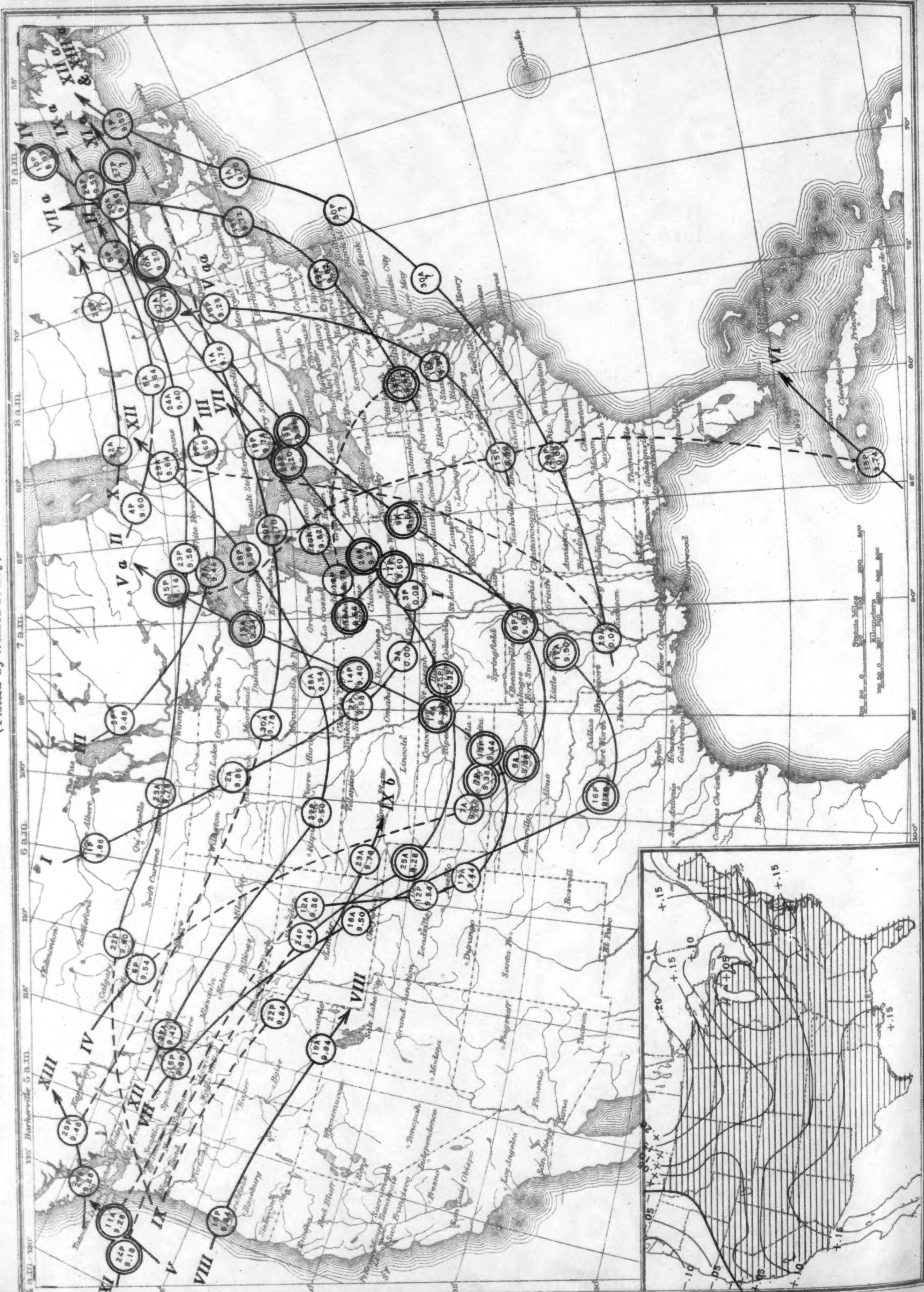
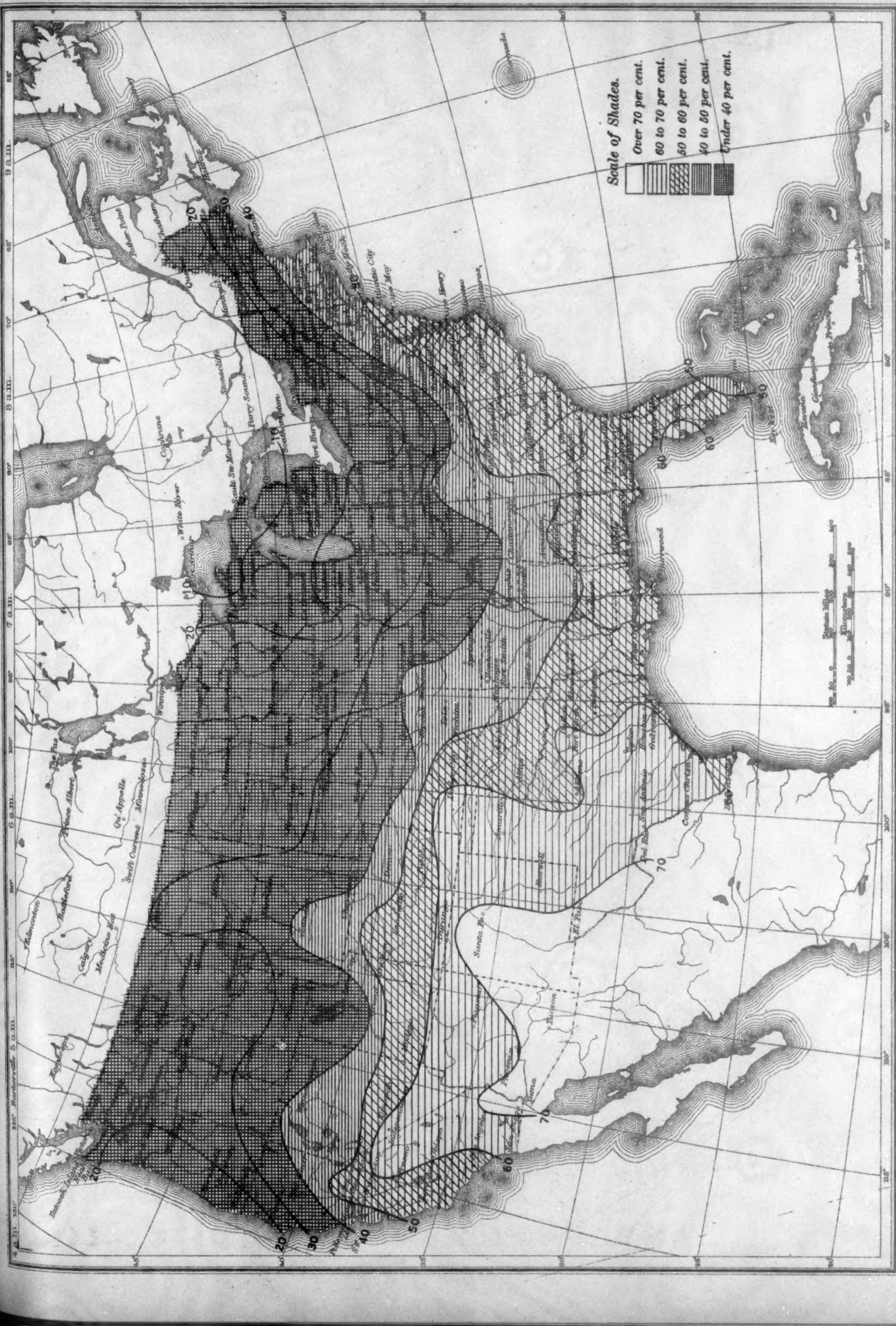


Chart II. Tracks of Centers of Cyclones, November, 1926. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by Wilfred P. Day)


Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.

Chart IV. Total Precipitation, Inches, November, 1926. (Inset) Departure of Precipitation from Normal

Chart V. Percentage of Clear Sky between Sunrise and Sunset, November, 1926



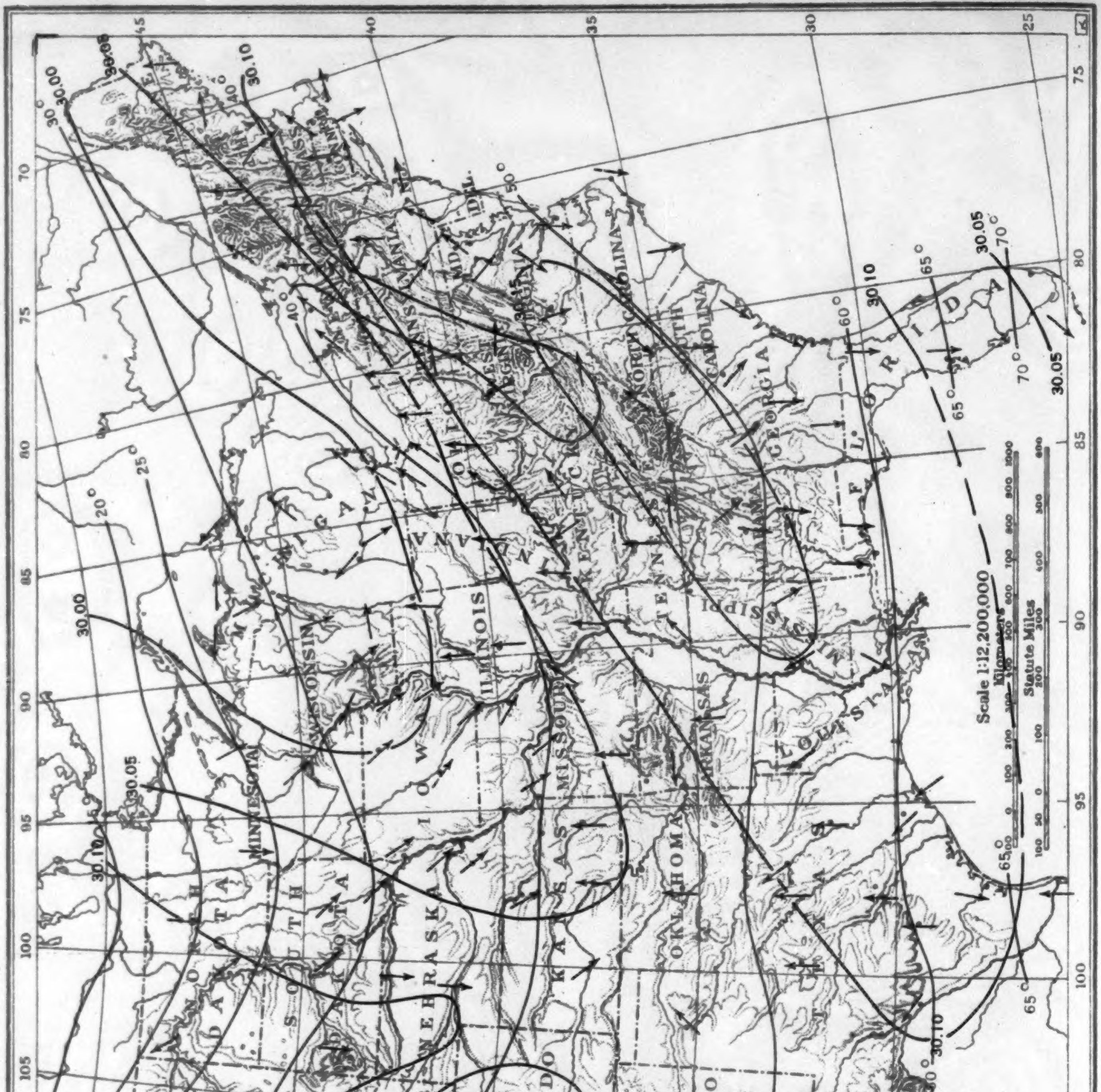


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, November, 1926

Chart VII. Total Snowfall, Inches, November, 1926. (Inset) Depth of Snow on Ground at end of Month

Chart VIII. Weather Map of North Atlantic Ocean, November 16, 1926

(Plotted by F. A. Young)

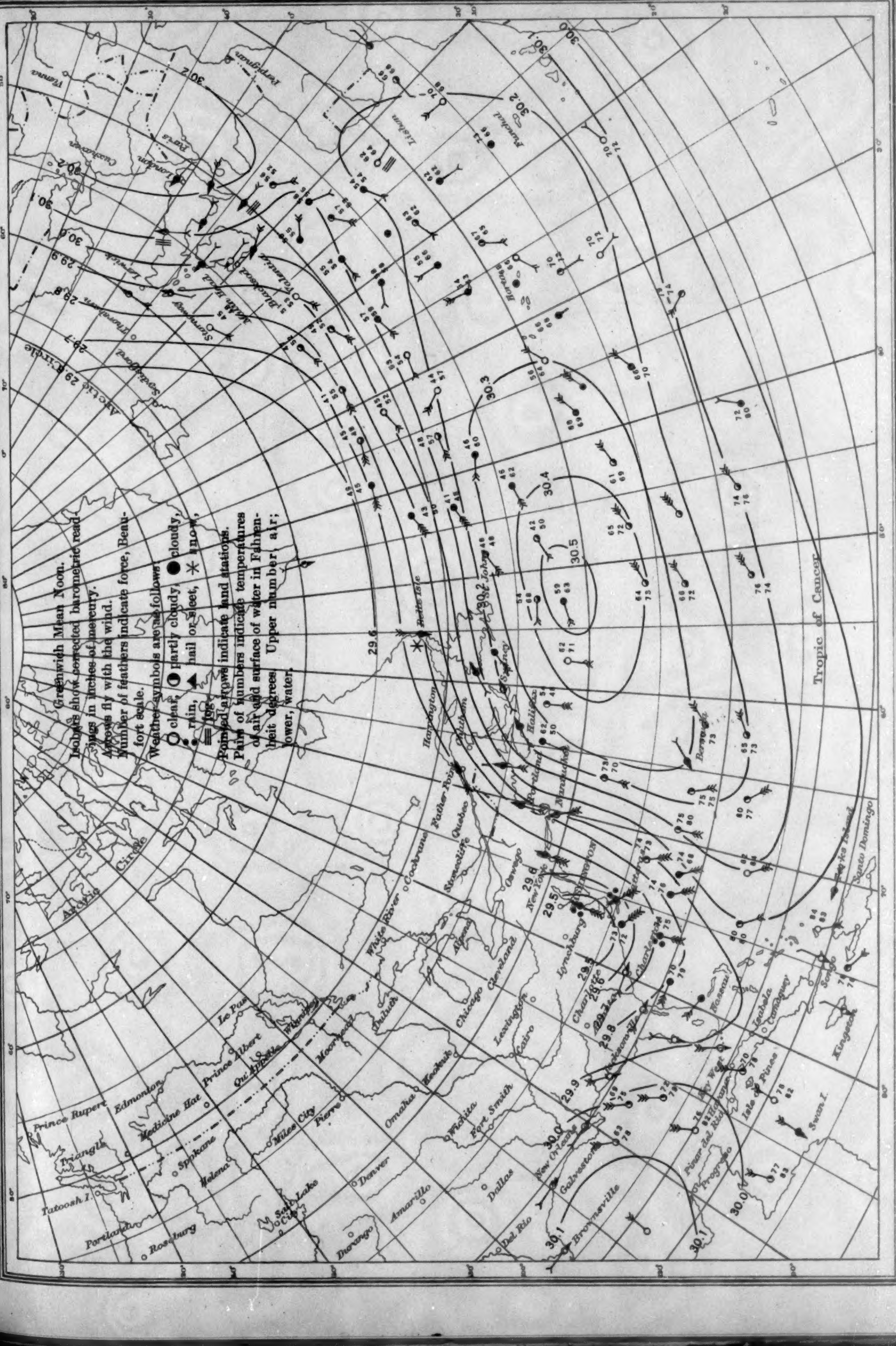


Chart IX. Weather Map of North Atlantic Ocean, November 17, 1926

(Plotted by F. A. Young)

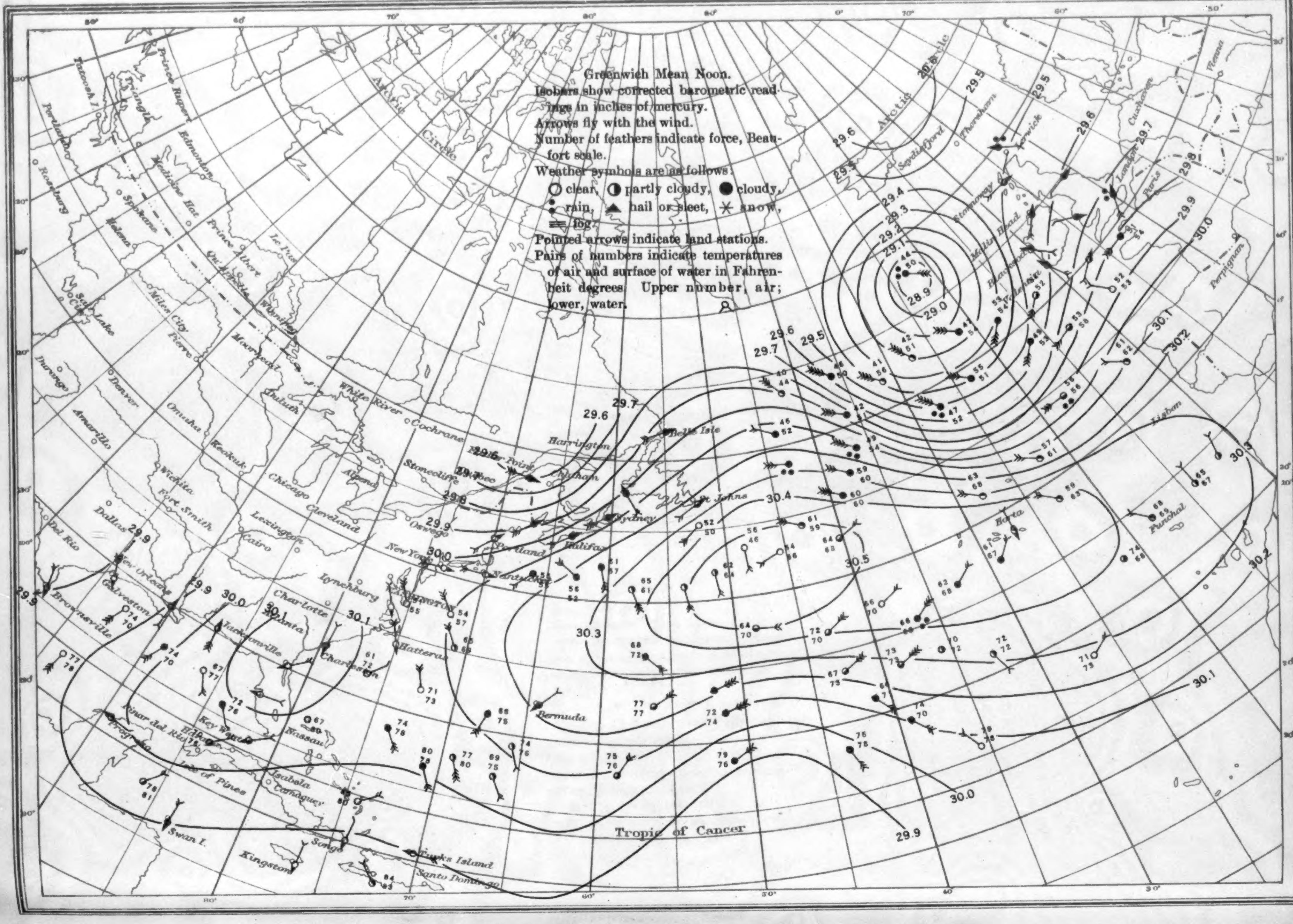


Chart X. Weather Map of North Atlantic Ocean, November 18, 1926
(Plotted by F. A. Young)

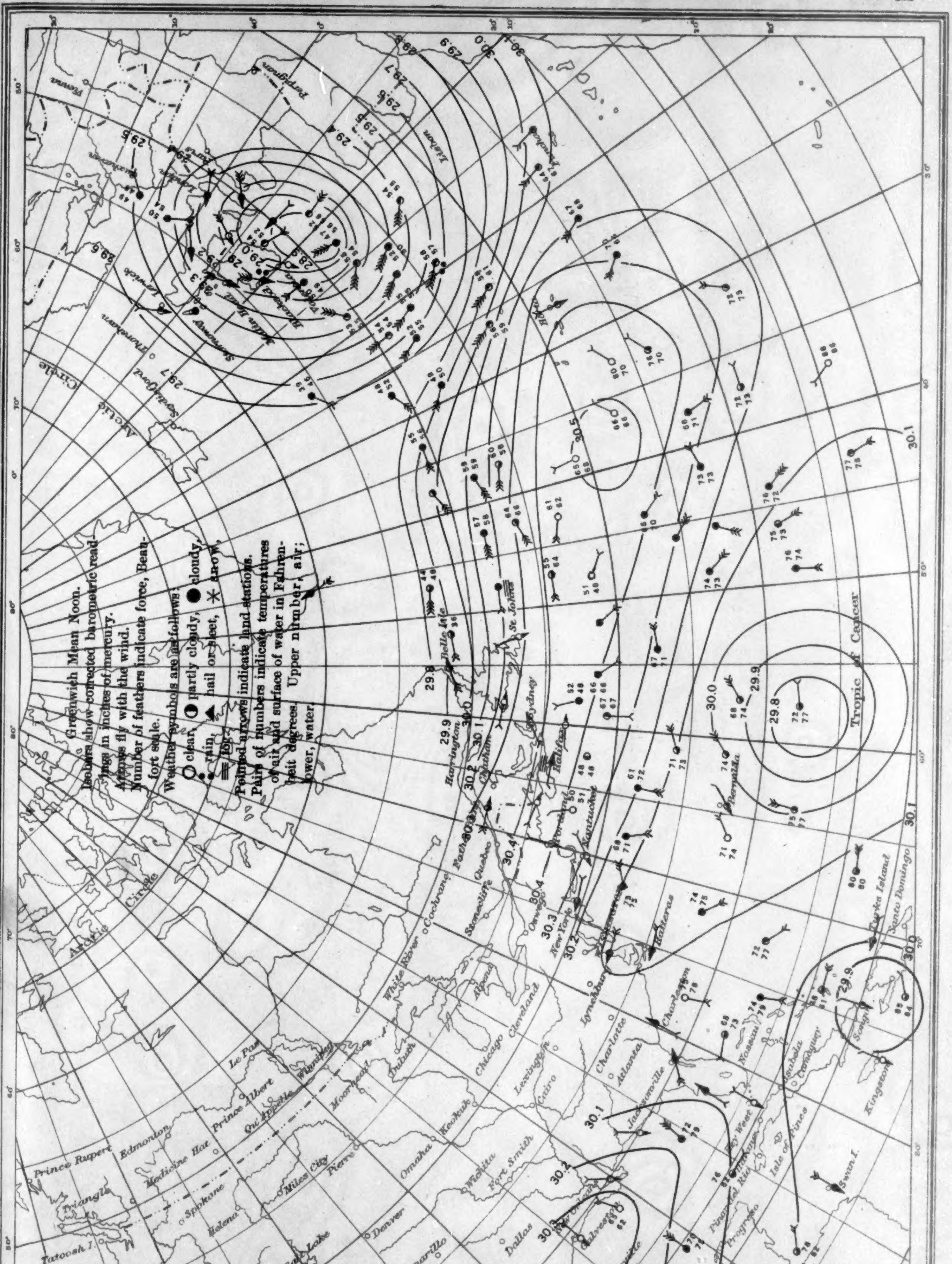


Chart XI. Weather Map of North Atlantic Ocean, November 19, 1926

(Plotted by F. A. Young)